

**FINAL**  
**FEASIBILITY STUDY REPORT**  
**OMEGA CHEMICAL CORPORATION SUPERFUND SITE**  
**OPERABLE UNIT 2**  
**WHITTIER, CALIFORNIA**

**EPA Contract No. EP-S9-08-03**  
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# Acronyms

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1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
1,2-DCE	1,2-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
AAQS	ambient air quality standard
AMK	Angeles Chemical and McKesson Chemical
AOC	Administrative Order Consent
AOP	advanced oxidation process
ARAR	Applicable or Relevant and Appropriate Requirement
AS	air sparging
BACT	best available control technology
BAT	best available technology
bgs	below ground surface
Bio-LGAC	biological liquid-phase granular activated carbon
BMP	best management practices
BTEX	benzene, ethylbenzene, toluene, and xylene
Cal-EPA	California Environmental Protection Agency
CA	Cost Analysis; California
CBMWD	Central Basin Municipal Water District
CCR	<i>California Code of Regulations</i>
CD	Consent Decree
CDFG	California Department of Fish and Game
CDM	Camp, Dresser & McKee
CDPH	California Department of Public Health
CDWR	California Department of Water Resources
CE	central extraction

CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	<i>Code of Federal Regulations</i>
CIP	clean-in-place
COC	contaminant of concern
COPC	contaminant of potential concern
CPT	cone penetrometer test
Cr+3	trivalent chromium
Cr+6	hexavalent chromium
CTR	California Toxics Rule
CWCB	Central and West Coast Basin
DPW	Department of Public Works
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EE	Engineering Evaluation
EPA	U.S. Environmental Protection Agency
FBR	fluidized-bed reactor
Fe	iron
FS	feasibility study
ft/day	foot (feet) per day
ft/ft	foot (feet) per foot
ft/y	foot (feet) per year
GAC	granular activated carbon
GHG	greenhouse gas
gpd	gallon(s) per day
gpm	gallon(s) per minute
GRA	General Response Action
GSWC	Golden State Water Company
GWTP	groundwater treatment plant

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H&SC	Health and Safety Code
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHRA	human health risk assessment
HI	hazard index
HSA	hollow-stem auger
IC	institutional controls
ISB	in situ bioremediation
IX	ion exchange
$K_r$	horizontal hydraulic conductivity
$K_z/K_r$	vertical to horizontal anisotropy ratio
kW	kilowatt(s)
LACDHS	Los Angeles County Department of Health Services
LACDPW	Los Angeles County Department of Public Works
LACSD	Sanitation Districts of Los Angeles County
LE	leading edge
LGAC	liquid-phase granular activated carbon
$\mu\text{g/L}$	microgram(s) per liter
MCL	maximum contaminant level
MG	million gallon(s)
$\text{mg/L}$	milligram(s) per liter
MICR	maximum individual cancer risks
Mn	manganese
msl	mean sea level
MUN	municipal water supply
MWD	Metropolitan Water District of Southern California
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	nondetection
NDMA	n-nitrosodimethylamine
NE	northern extraction
NF	nanofiltration

NIU	Newport-Inglewood Uplift
NL	Notification Level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NPV	net present value
NSF	NSF International
NWU	Non-Consumptive Water Use (Permit)
O&M	operations and maintenance
O <sub>3</sub>	ozone
OFRP	Oil Field Reclamation Project
OPOG	Omega Chemical Site PRP Organized Group
OSHA	Occupational Safety and Health Administration
OSS	Onsite Soils
OSVOG	Omega Small Volume Organized Group
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
O <sub>x</sub>	oxidant
PCE	tetrachloroethene
PHG	Public Health Goal
PM	particulate matter
POTW	publicly owned treatment works
ppb	part(s) per billion
ppm	part(s) per million
PRB	permeable reactive barrier
PRP	Potentially Responsible Party
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
redox	reduction-oxidation reaction

RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RO	reverse osmosis
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SCAQMD	South Coast Air Quality Management District
SDWA	Safe Drinking Water Act
SIP	State Implementation Plan
Site	Omega Chemical Corporation Superfund Site
SO <sub>4</sub>	sulfate
SOW	Statement of Work
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWRCB	State Water Resources Control Board
T-BACT	best available control technology for toxics
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethene
TDS	total dissolved solids
TMV	toxicity, mobility, or volume
UAO	Unilateral Administrative Order
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UST	underground storage tank
UV	ultraviolet
VFD	variable frequency drive
VGAC	vapor-phase granular activated carbon
VOC	volatile organic compound

WQO	water quality objectives
WRD	Water Replenishment District
WRP	water reclamation plant

# 1. Introduction

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The United States Environmental Protection Agency (EPA), under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), is conducting a remedial investigation/feasibility study (RI/FS) to address groundwater contamination at Operable Unit (OU) 2 of the Omega Chemical Corporation Superfund Site (Omega Site). This report documents the FS work conducted to address groundwater contamination at OU2, downgradient of the former Omega Chemical Corporation (Omega) property located in Whittier, California (Figure 1-1). Specifically, the FS develops and evaluates alternative remedial actions (RAs) to address the contaminated groundwater at OU2.

In accordance with CERCLA, remedial alternatives must be appropriate to site-specific conditions and protective of human health and the environment. The RI/FS process is the established methodology to develop such alternatives. The RI serves as a mechanism to collect data for site characterization. The FS serves as a mechanism to develop, screen, and evaluate remedial alternatives using the data gathered during the RI.

The Omega Site was placed on the EPA National Priorities List (NPL) in January 1999. EPA manages the Omega Site as three OUs (OUs 1 through 3). OU1 includes the contaminated soil and groundwater at and in the immediate vicinity of the former Omega property; OU2 is composed of groundwater contamination outside and generally downgradient (south-southwest) of OU1; and OU3 is composed of indoor air contamination at buildings located on and near the former Omega property. The three OUs are being addressed separately. EPA has conducted the RI/FS for OU2. The Omega Chemical Site Potentially Responsible Party (PRP) Organized Group (OPOG) has completed the RI/FS for OU1 soils, an Engineering Evaluation/Cost Analysis (EE/CA) for OU1 groundwater, and has constructed an interim groundwater treatment system to contain contaminated OU1 groundwater. OPOG is performing indoor air contamination removal activities under an agreement with EPA. In September 2008, EPA issued a Record of Decision (ROD) to document its selection of the remedy for OU1 soils. OPOG has agreed to implement the OU1 soils remedy and will begin design work in late 2010. EPA oversees the OPOG OU1 and OU3 work.

The FS is based on the results documented in the RI report for Omega OU2 (CH2M HILL, 2010). The RI work completed to date is deemed to be sufficient for the purpose of the FS (i.e., to develop and evaluate remedial alternatives). It should be noted that additional data collection and analysis from ongoing monitoring will continue; however, these additional data should not impact the basic remedial alternatives developed for purposes of an interim containment remedy as evaluated in this FS. Rather, this supplemental data collection and analysis will help to further define the nature and extent of contamination at OU2 in more detail, will support remedial design (RD), and will be used in support of EPA enforcement actions.

The main components of a typical groundwater remedy include the containment of the contaminant plume in groundwater to prevent its further spreading, control of sources of contamination and reduction of contaminant mass at source areas, and cleanup of the

contaminated aquifer. The area of highly contaminated groundwater within OU1 is controlled by an interim pump and treat system that began operation in July 2009, and RD/RA work on the soil remedy for OU1 (soil vapor extraction throughout the vadose zone) will begin in 2010. The investigation and cleanup work at approximately 20 source areas of significantly contaminated soils and groundwater at OU2 that were identified in the RI are under state oversight (either Department of Toxic Substances Control [DTSC] or Regional Water Quality Control Board [RWQCB]); it is assumed that the state will require source control actions at these facilities as needed.

Given the large number of potential sources (other than Omega) and the presence of water supply wells in the area, EPA decided to pursue an interim containment remedy for the contaminated groundwater at OU2. Consequently, this FS develops and evaluates alternatives for a plume containment remedy for OU2. Following implementation of the interim remedy, EPA will evaluate the feasibility of plumewide cleanup of the contaminated aquifer.

The interim OU2 remedy will work in parallel with the interim groundwater remedy and soil cleanup actions at OU1 and state-led cleanup actions at the approximately 20 source areas overlying the OU2 plume. This approach allows cleanup to move forward under the state-led actions for the source areas and under EPA-led action for the commingled OU2 plume. The remedial alternatives for the interim OU2 remedy developed in this FS are expected to be consistent with the state-led actions and with the final OU2 remedy.

## 1.1 Feasibility Study Purpose

The purpose of the FS presented in this report is to develop and evaluate remedial alternatives that mitigate threats to human health and the environment from the continued spread of contaminated groundwater at OU2. The FS has been carried out in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988). Pursuant to the guidance, the remedial alternatives are evaluated in this FS according to their ability to meet the following criteria:

1. Overall protection of human health and the environment
2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, and volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost

Alternatives will be evaluated against two additional criteria – state acceptance and community acceptance – prior to the selection of a remedy. This evaluation will take place after the review by the California DTSC, the lead state agency for the Site, and public comment on the FS and the upcoming proposed plan, and will be documented in a ROD.

## 1.2 Report Organization

This FS Report is organized as follows:

- **Section 1.0 – Introduction.** Summarizes Omega Site location, operation history, regulatory enforcement history, past remedial activity, investigation, physical and hydrogeologic settings, nature and extent of contamination at the Omega Site, contaminant fate and transport at the Omega Site, and risk assessment conducted during the RI.
- **Section 2.0 – Identification and Screening of Remedial Technologies.** Describes the development of remedial action objectives (RAOs) (including the area of groundwater contamination targeted for remediation) and identification of potential ARARs; identifies general response actions (GRAs), remedial technologies, and process options; and screens the remedial technologies and process options for effectiveness, implementability, and cost.
- **Section 3.0 – Remedial Alternatives Development.** Develops remedial alternatives by combining retained remedial technologies and process options.
- **Section 4.0 – Detailed Analysis of Remedial Alternatives.** Provides detailed analysis of remedial alternatives based on the seven criteria listed in Section 1.1.
- **Section 5.0 – References.** Lists the documents referenced in this FS Report.

## 1.3 Site Background

This section provides brief descriptions of the Omega Site location, operation, and regulation history. It also provides a summary of past soil and groundwater investigations at the Omega Site.

### 1.3.1 Site Location

The former Omega facility is located at 12504 and 12512 East Whittier Boulevard, Whittier, California, approximately 100 feet west-southwest of Putnam Street (Figure 1-2). The Omega property occupies Los Angeles County Assessor Tract Number 13486 (Lots 3 and 4). It covers an area of approximately 41,000 square feet (200 feet wide by 205 feet long) and contains two structures—a 140- by 50-foot warehouse and an 80- by 30-foot administrative building. A loading dock is attached to the rear of the warehouse. The Omega property is paved with concrete and secured with a 7-foot-high perimeter fence and locking gate. The fence is topped with razor wire.

Omega OU2 generally includes the groundwater-contaminated area that extends from the former Omega facility for approximately 4.5 miles in a south-southwesterly direction. An Omega Site map showing the approximate OU2 boundary is presented in Figure 1-3. The Omega Site and surrounding areas are completely developed with residential, industrial, or commercial facilities; no undeveloped properties remain in this area.

## 1.3.2 Current Use and Operational History of the Omega Facility

### 1.3.2.1 Current Use

Van Owen Holdings LLC of Los Angeles, California, purchased the Omega property in 2003 and owns the property to the present day. The former Omega facility was located on the following two parcels:

- **Northern parcel – 12504 Whittier Boulevard.** Currently being leased by Star City Auto Body to conduct automotive body repair and painting. The auto body shop also leases the small paved parking lot north of the warehouse building for automobile parking.
- **Southern parcel – 12512 Whittier Boulevard.** The former administrative building and the paved parking area south of the warehouse have had a variety of tenants since the 2003 purchase of the property. The former administrative building is currently vacant. The building was previously used for administration and equipment storage, while the concrete-paved exterior yard was used for parking and temporary storage of heavy construction equipment.

### 1.3.2.2 Former Uses

The known environmental history of the Omega property was documented in the *Data Summary Report for On-Site Soils* prepared by Camp, Dresser & McKee (CDM) in December 2001 (CDM, 2001) and a Facility History Memorandum prepared by Science Applications International Corporation (SAIC) in July 2006 (SAIC, 2006). The following list summarizes the history of property owners and operators:

- Late 1930s – Property was undeveloped or used for agricultural purposes.
- 1951 – Property was developed in July 1951; office and warehouse were constructed for Sierra Manufacturing Company, renamed as Sierra Bullets, Inc. in 1955. Operations included manufacturing of metal-jacketed rifle and pistol projectiles and metal cups for detonation devices. During operation of the Sierra Bullet facility, a 500-gallon underground storage tank (UST) was used for storage of kerosene. Sierra Bullets also reportedly used trichloroethene (TCE).
- 1963 through 1966 – Northern property was purchased and occupied by Fred R. Rippy, Inc. for the purposes of die making and operation of a stamping machine shop.
- 1966 through 1974 – Northern property was used to convert vans to ambulances.
- 1974 through 1976 – Northern property occupied by Bachelor Chemical Processing. Operations reportedly included the recycling of Freons.
- 1976 – Omega Chemical Corporation (Mr. Dennis O'Meara) purchased Bachelor Chemical Processing (northern parcel) and assumed the property lease.
- 1987 – Omega purchased the leased parcel and adjoining southern parcel from Rippy. The former Omega facility provided treatment of commercial and industrial solid and liquid wastes and a transfer station for the storage and consolidation of wastes to be shipped to other treatment or disposal facilities. According to its October 29, 1990, Operation Plan for Hazardous Waste Recovery, the Omega facility maintained

11 treatment units composed of distillation columns, reactors, a wipe film processor, a liquid extractor, and a solid waste grinder. The facility also maintained 22 stainless-steel tanks with capacities ranging from 500 to 10,000 gallons and five carbon steel tanks with capacities of 5,000 gallons (CDM, 2001).

- April 11, 1991 – Omega was ordered by the Superior Court of the County of Los Angeles to cease operation, remove all hazardous wastes, and close the facility.
- September 1991 – Omega filed Chapter 11 bankruptcy, which was dismissed on September 7, 1993.
- Approximately 1999 through 2001 – Northern parcel (12504 Whittier Boulevard) was leased by Mr. Nicholas Stymuiank who occupied the warehouse and stored miscellaneous equipment and materials in the warehouse and service yards.
- 2003 – The warehouse on the northern parcel was converted to be used by Star City Auto Body for auto body repair.
- During the past few years – Several tenants have occupied the southern parcel (12512 Whittier Boulevard). C&I Electric used the property for equipment and billboard storage. Following the termination of the C&I Electric lease, Three Kings Construction occupied the property. In December 2006, L&M Pallets leased the exterior yard for pallet storage. The parcel is currently unoccupied.

### 1.3.3 Regulatory History and Past Site Remediation Activities

The following summary of the regulatory history of the former Omega facility was based on information summarized in the *Request for a Removal Action at the Omega Chemical Site, Whittier, California* (EPA, 2006) and the *Onsite Soils (OSS) RI/FS Work Plan* (CDM, 2003).

Environmental regulatory action at the Omega Site began with several notices of violations from the Los Angeles County Department of Health Services (LACDHS). In November 1990, the Los Angeles County Superior Court issued a preliminary injunction to prevent further acceptance of offsite hazardous waste. In February 1991, Los Angeles County and San Bernardino County District Attorneys' offices issued warrants to search three railcars at the facility. The search revealed illegal storage and transport of 700 hazardous waste drums, falsified waste manifests, and drum labels. As a result, the Los Angeles County Superior Court ordered Omega to cease all operations, remove all hazardous wastes, and close the facility. EPA entered into an Administrative Order of Consent (AOC) in October 1991, requiring Omega to perform several interim measures to mitigate current or potential threats to human health and the environment and to submit a Resource Conservation and Recovery Act (RCRA) facility investigation. At that time, the California Environmental Protection Agency (Cal-EPA)/DTSC was the lead agency at the Omega Site.

Although the Omega facility officially closed in 1991, the president and owner of the company continued to operate under a different company name on a limited basis, accepting primarily refrigerants (Freons). DTSC requested assistance from EPA to conduct a site assessment in August 1993. The site assessment revealed that approximately 2,900 drums of hazardous waste were at the facility in weathered condition, but not completely corroded or leaking. In 1995, the company manager was found guilty of

contempt of court by the Los Angeles County Superior Court and was ordered to cease all operations. Operations ceased at the Omega facility at that time.

On May 9, 1995, EPA issued a Unilateral Administrative Order (UAO) for drum removal and preliminary investigation work to PRPs that had shipped more than 10 tons of hazardous wastes to Omega. At that time, EPA became the lead agency at the Omega Site. The PRPs subsequently formed OPOG to perform the work. Between 1995 and 1996, OPOG removed approximately 2,700 drums from the facility and conducted a preliminary site investigation. By that time, a majority of the drums were in extremely poor condition, and spills were observed in numerous locations. The Omega Site was placed on the NPL in January 1999. OPOG entered into a partial Consent Decree (CD) with the United States in February 2001. Under the CD Statement of Work (SOW), OPOG has performed an RI/FS for the vadose zone soil at OU1, including a human health risk assessment (HHRA) for the vadose zone soils; completed an EE/CA to evaluate OU1 groundwater cleanup alternatives; and installed an interim groundwater remedy. The OU1 interim groundwater remedy is composed of five extraction wells located immediately downgradient of the former Omega property along Putnam Street. The objective of the OU1 interim remedy is to prevent volatile organic compound (VOC) contaminants originating from the Omega facility from entering the downgradient groundwater.

During the evaluation of data collected for the OU1 RI, it was found that soil vapor had migrated into several buildings near or at the former Omega property, including “Skateland,” an indoor roller-skating rink. EPA created OU3 to address indoor air contamination (i.e., vapor intrusion) at Skateland and potentially other buildings. In April 2006, EPA issued an Action Memorandum for a removal action to mitigate the vapor intrusion at Skateland. Pursuant to the First Amendment to the CD, OPOG agreed to mitigate the indoor vapor exposure at Skateland or conduct an alternate response action (EPA, 2006). After undertaking some of the testing work prior to selecting an appropriate mitigation measure, OPOG elected to purchase the property and close Skateland operations. The Skateland building was subsequently demolished in March 2007.

In January 2004, EPA issued a UAO (the 2004 UAO; EPA, 2004a) to certain PRPs that had not signed the Partial CD to perform RI/FS work. The 2004 UAO was amended in June 2004 (First Amended UAO; EPA, 2004b). Fifteen of the parties named in the First Amended UAO formed the Omega Small Volume Organized Group (OSVOG) and installed monitoring wells as part of the RI for OU2.

Pursuant to an AOC effective in November 2009, OPOG agreed to address indoor air contamination at several buildings located on and near the former Omega property. Among other requirements, the AOC requires OPOG to construct a soil vapor extraction system and to monitor indoor air contamination at such buildings.

### **1.3.4 Historical and Current OU2 Site Investigation**

Site investigation at Omega OU2 was started in 2001 by Weston Solutions, Inc. (Weston) on behalf of EPA. Weston performed OU2 investigations in 2001 to 2002 and prepared two groundwater characterization reports (Weston, 2002 and 2003). OSVOG installed groundwater monitoring wells at OU2 in 2005 and 2006 (ARCADIS, 2007). CH2M HILL continued the OU2 site investigation on behalf of EPA and completed the RI for OU2 in 2010

(CH2M HILL, 2010). The RI report describes in detail the investigation activities and major findings from these activities. A brief summary of the OU2 site investigation activities is provided in the following subsections.

#### **1.3.4.1 Site Investigation Performed by Weston**

Weston, on behalf of EPA, started the initial phase site investigation in 2001 by installing 30 cone penetrometer test (CPT) probes. Results of the initial phase are included in the Phase 1 Groundwater Characterization Study (Weston, 2002). Weston performed the second phase site investigation by installing six CPT probes and 19 hollow-stem auger (HSA) borings and 18 monitoring wells. Lithologic logging was conducted and groundwater samples were collected from CPT and monitoring wells during the two phases of field investigations. Results of these field investigations are documented in the Phase 1 and Phase 2 Groundwater Characterization Study, respectively (Weston, 2002 and 2003).

The 18 monitoring wells have been sampled quarterly since February 2002. CH2M HILL began routine sampling of these wells in March 2004. Results of the groundwater sampling are presented in quarterly groundwater monitoring reports submitted to EPA.

#### **1.3.4.2 Site Investigation Performed by OSVOG**

ARCADIS, on behalf of OSVOG, installed 23 monitoring wells (at 12 locations) and one extraction well between May 2005 and April 2006, and sampled the new wells in June 2006. The results of this investigation are published in the Final Project Completion Report (ARCADIS, 2007). CH2M HILL performed oversight of the ARCADIS construction activities.

Following the completion of the OSVOG site investigation work, EPA evaluated the information gathered to date and concluded that additional investigation was needed to further characterize the hydrogeological conditions as well as the nature and extent of groundwater contamination at OU2. EPA retained CH2M HILL to complete these additional investigations as summarized in this section.

#### **1.3.4.3 File Review Conducted by CH2M HILL in 2005**

CH2M HILL, on behalf of EPA, conducted a file review in 2005 to identify facilities that are potential sources of groundwater contamination in OU2 (other than the former Omega facility). CH2M HILL reviewed state and local agency files for facilities within the OU2 area and developed a list of known or potential sources of VOC contamination in groundwater in the area (CH2M HILL, 2010). EPA continues further records searches at the present time.

#### **1.3.4.4 Field Investigation Conducted by CH2M HILL**

CH2M HILL conducted further field investigations at Omega OU2 between March 2004 and July 2007 (CH2M HILL, 2010). Field activities conducted included the following:

- Installation of four single-screen and four quadruple-nested monitoring wells to characterize the vertical and lateral extent of the contaminant plume in 2007
- HydroPunch® groundwater sampling conducted in 2007 to identify sources of VOC contamination (other than the former Omega facility)

- Groundwater sampling at all OU2 wells and acquisition of groundwater monitoring data for OU1 and other sites at and near OU2
- Soil gas investigation conducted in 2007 to characterize the risk of soil gas vapor intrusion into residential buildings
- Pumping tests and slug tests conducted in 2008 to characterize the aquifer properties at OU2

EPA completed the RI at Omega OU2 by publishing an RI report (CH2M HILL, 2010). The RI report includes all the data and information related to Omega OU2 gathered by different parties, and it documents the development of a hydrogeologic conceptual model of the Omega Site. The RI report also presents a numerical groundwater model for OU2 developed as part of the RI. The Omega model is based on the conceptual hydrogeologic model for the OU2 area and on a previous, large-scale model prepared by the United States Geological Survey (USGS) (Reichard et al., 2003). The model is transient and was calibrated for the period between October 1970 and July 2006, a period covering the operation histories of the facilities that are known to be major contaminant sources for the groundwater contamination at OU2. The model is capable of reproducing the temporal water level trends and the groundwater flow patterns and main flow pathways at OU2.

## **1.4 Site Setting**

### **1.4.1 Physical Setting**

The former Omega facility is located in Whittier, California, along the base of the La Habra piedmont slope descending from the southeastern flank of the Puente Hills at an elevation of approximately 220 feet above mean sea level (msl). The piedmont slope slants southwest at approximately 2.5 percent, flattens out at approximately 150 feet above msl, and then rises gently to 160 feet above msl in the southwestern portion of OU2. The Omega Site and surrounding areas are completely developed.

### **1.4.2 Hydrogeologic Setting**

#### **1.4.2.1 Regional Hydrogeology**

The Omega Site is located in the Montebello Forebay and the Whittier area of the Central Basin, a subbasin of the Coastal Plain of Los Angeles County, California. The Coastal Plain is bounded on the west and south by the Pacific Ocean and by mountains on the north, east, and southeast.

The Central Basin extends over most of the Coastal Plain of Los Angeles east and northeast of the Newport-Inglewood Uplift (NIU). It is bounded on the north by a series of low hills from Elysian Hills in the northwest and Puente Hills in the southeast, on the west and south by the NIU, and on the southeast by the Los Angeles/Orange County Line (Figure 1-1). The NIU is an important regional structural feature extending from the Newport Mesa in Orange County northwesterly to Beverly Hills. The NIU is a series of en echelon (i.e., sub-parallel, formed in response to the same stress) anticlinal folds and discontinuous faults. The faults of the NIU exert considerable barrier influence upon the movement of subsurface water (California Department of Water Resources [CDWR], 1961).

The Coastal Plain is underlain by an extensive groundwater basin in Los Angeles and Orange Counties. According to Bulletin 104 (CDWR, 1961), water-bearing sediments identified in the Whittier area extend to an approximate depth of at least 1,000 feet below ground surface (bgs). The main geologic units consist of recent alluvium, the upper Pleistocene Lakewood Formation, and the lower Pleistocene San Pedro Formation. The San Gabriel River and the Rio Hondo are two important surface streams entering the Central Basin through the Whittier Narrows. The area downstream of the Whittier Narrows is known as the Montebello Forebay, where surface water could freely percolate into the groundwater system. The non-forebay part of the Central Basin, where such percolation is restricted by shallow fine-grained sediments, is often referred to as the Pressure Area (CDWR, 1961).

Most of the surface streams in the Central Basin are concrete lined, and recharge through the bottoms of these stream channels is assumed to be negligible. Exceptions to this are engineered recharge zones, the Rio Hondo and San Gabriel spreading basins, and the unlined section of the San Gabriel River downgradient of the spreading basin extending approximately to Florence Avenue (Figure 1-1). The unlined section of the San Gabriel River is also referred to as the lower San Gabriel River recharge area (CH2M HILL, 2010).

The San Gabriel and the Rio Hondo spreading basins are the major groundwater replenishment sources for the Central Basin. Areal recharge including infiltration from precipitation and return flow from irrigation and mountain front recharge occurring along the basin boundaries are the remaining, but much smaller, groundwater recharge components in the Central Basin.

Numerous production wells are located within the Central Basin. Most of these production wells are screened in the deeper portion of the aquifer at depths generally greater than 200 feet bgs (Reichard et al., 2003).

Groundwater flows generally to the southwest in the Montebello Forebay, and then turns to the south-southwest in the Central Basin pressure area. The groundwater flow in the Central Basin is mainly controlled by natural and artificial recharge in the Montebello Forebay and production pumping (CDWR, 1961).

#### **1.4.2.2 Local Hydrogeology**

Shallow deposits at OU2 consist of unconsolidated sands and silts. The sands are formed by an interconnected system of fluvial channels within the stratigraphic framework of the major geologic structures at OU2 including the northwest-trending La Habra syncline and west-northwest trending Santa Fe Springs anticline. The stratigraphic interpretations discussed in this section are based on piezometric heads, boring logs, and downhole geophysical logs of the OU1 and OU2 monitoring wells and nearby production wells. In addition, the OU2 stratigraphic interpretation also relied on information on the deeper structure of the basin to infer the locations of fold axes and the dip of hydrostratigraphic units. USGS provided a preliminary interpretation of oil industry seismic reflection surveys and of the shallow sediments at OU2 based on the data collected during the RI.

The former Omega facility is underlain by relatively low permeability silty and clayey soils to a depth of about 120 feet bgs. These fine-grained soils transition into a sand unit that has been encountered approximately 200 feet southwest of the facility beneath Putnam Street

(Figure 4-7 of the RI report; CH2M HILL, 2010); this unit contains the shallowest groundwater at OU1, generally at a depth of approximately 70 feet bgs in July through August 2007. A deeper, semiconfined aquifer unit was found at OU1 at a depth of approximately 112 feet bgs along Putnam Street. Piezometric heads in the deeper aquifer are about 7 to 13 feet lower compared to the heads in the water table aquifer at OU1, indicating substantial hydraulic separation between the two units.

The RI identified one Holocene and six Pleistocene stratigraphic units present throughout OU2. Unsaturated Holocene deposits are found at and near the former Omega facility and in the downgradient area of OU2, but are absent across the anticline (between Wells MW25 and MW27). A thin veneer of recent alluvium derived from the Puente Hills covers the floodplain sediments at and northeast of the former Omega property. The principal Santa Fe Springs anticline crest lies between Wells MW25 and MW26; the La Habra syncline axis is near Well MW15. Both fold axes are near their locations shown in Saucedo et al. (2003).

The deposition of the units is thought to be largely controlled by base level changes; consequently, lateral facies transitions reflect different depositional environments (e.g., near-shore marine and floodplain) within each stratigraphic unit. Generally, coarser materials are found at the base of the stratigraphic units that transition upward into finer-grained materials, as indicated by relatively high and low resistivity, respectively, on geophysical logs. This stacking pattern suggests most of these deposits are of floodplain, rather than of marine origin.

According to the water head data collected in July through August 2007, the depth-to-groundwater at OU1 and OU2 ranges from 22.90 feet bgs at MW7 to 92.07 feet bgs at MW27C. The water table slopes from 135 feet above msl at the former Omega property to about 15 feet above msl (MW30) near the southern edge of OU2, approximately 4.5 miles away (Figure 1-4). In 2007, the average shallow groundwater gradient along the flow path from the former Omega property to MW30, the farthest downgradient well, was 0.0049 foot per foot (ft/ft). However, groundwater gradient varies across OU2. The shallow groundwater gradient between the former Omega property and Sorensen Avenue is about 0.0012 ft/ft to the southwest. The gradient becomes steeper, 0.0076 ft/ft, between Sorensen Avenue and Florence Avenue, and its direction gradually turns from the southwest to the south-southwest. Near Lakeland Road, the gradient is due south. Between Lakeland Road and Imperial Boulevard, the gradient decreases to 0.0030 ft/ft and turns to the south-southeast. The fine-grained units, although locally discontinuous, generally provide hydraulic separation between overlying and underlying sands. Piezometric heads measured in OU1 and OU2 wells generally, but not always, decline with the depth of the hydrostratigraphic unit that the well is screened in; the differences between heads at multiple-screen wells are up to about 25 feet (based on July through August 2007 measurements).

Water levels at OU1 and OU2 declined between 2001 and 2004, rebounded after heavy precipitation in 2005, remained approximately steady in 2006 and 2007, and declined again after 2007. Despite the water level fluctuation over time, the general groundwater flow direction and gradient have remained relatively constant at OU2 since at least 2002.

Twelve production wells are known to exist at OU2. Four of them are screened at depths greater than 300 feet bgs or are nonoperational. Five of the production wells in the OU2 area

(Figure 1-3) are known to have been impacted by VOCs and are discussed further. The nearest well (02S11W30-R3), also known as SFS No. 1, is located 1.3 miles to the west-southwest of the Omega facility, at the Santa Fe Springs Fire Station on Dice Road near Burke Street and is owned and operated by the City of Santa Fe Springs. This well is screened from 200 to 900 feet bgs (with a blank screen segment between 288 and 300 feet bgs), and operates at a rate of approximately 900 gallons per minute (gpm; CH2M HILL, 2010). Four active production wells are located near the leading edge of OU2—3S/11W-07E01S, 3S/11W-07E02S, 3S/12W-12A02S, and 3S/11W-18G05S. These wells are owned and operated by the Golden State Water Company (GSWC). Well 3S/11W-07E01S, known as GSWC Pioneer #1, is screened from 193 feet to 216 feet bgs and currently operates at about 540 gpm; Well 3S/11W-07E02S, known as GSWC Pioneer #2, is screened in two depth intervals, from 196 to 206 feet bgs and from 460 to 472 feet bgs, and currently operates at about 388 gpm; Well 3S/12W-12A02S, known as GSWC Pioneer #3, is screened from 194 to 218 feet bgs and currently operates at about 520 gpm; Well 3S/11W-18G05S, known as GSWC Dace #1, is screened in two depth intervals, from 200 to 260 feet bgs and from 266 to 402 feet bgs, and currently operates at about 310 gpm (Moore, 2009).

Both slug tests and pumping tests were conducted to estimate the distribution of hydraulic properties throughout the OU2 area. The estimated horizontal hydraulic conductivity ( $K_r$ ) ranged from 0.47 foot per day (ft/day) to 404 ft/day and the vertical to horizontal anisotropy ratio ( $K_z/K_r$ ) was estimated to be about 0.0092, indicative of alternating coarse- and fine-grained aquifer materials. The hydraulic conductivities estimated from aquifer tests are considered to be more representative of coarse-grained subunits because the monitoring wells on which the tests were performed were installed with screens across coarse-grained intervals.

## 1.5 Nature and Extent of Groundwater Contamination

The Omega Contaminants are chemicals found at concentrations exceeding their screening levels at OU1 area wells, including OW1A, OW1B, OW2, OW3A, OW3B, OW8A, and OW8B. The Omega Contaminants are believed to have been introduced to groundwater as a result of the release of hazardous substances at the former Omega facility. The hazardous substances released at the Omega property have entered into the aquifer, and while migrating with groundwater flow, have commingled with contaminants resulting from releases of hazardous substances at other source areas. Major chemical constituents of the releases at Omega and the downgradient sources are the same (e.g., tetrachloroethene [PCE] and TCE). Freon 11 and Freon 113, however, are considered tracers for the Omega Contaminants because the former Omega facility is the only confirmed source of Freons that have impacted OU2 groundwater.

Chemicals of potential concern (COPCs) for OU2 are defined as chemicals found at OUs 1 and 2 at concentrations exceeding their screening levels (e.g., California or federal primary maximum contaminant level [MCL] or California Department of Public Health [CDPH] Notification Level [NL]; CH2M HILL, 2010). They may have originated from the former Omega facility or from other known and unknown sources; they may also include naturally occurring compounds. Regardless of their origins, some or all of the COPCs must be addressed by the future OU2 remedy. For example, a potential remedy based on

groundwater extraction would require the treatment for some of these compounds depending on the end use of the treated water.

Omega Contaminants in groundwater extend laterally up to about 4.5 miles to the southwest from the Omega property. The plume extents vary among the different COPCs. The plume extents of the individual COPCs were estimated based primarily on the analytical results from the July through August 2007 sampling event. Historical concentration data from CPT borings and monitoring wells obtained during Omega investigations and information from other facilities at OU2 were also considered.

PCE is the main risk driver (98 percent of the risk) associated with the potential ingestion of the contaminated groundwater and is the most widely present contaminant at OU2. A detailed discussion of the groundwater contamination at OU2 and the HHRA is presented in the RI report (CH2M HILL, 2010). A brief summary of the main COPCs detected during the July through August 2007 sampling event is presented as follows:

- The maximum PCE detection of 90,000 micrograms per liter ( $\mu\text{g/L}$ ) was found in Well OW1A. The PCE plume with concentrations greater than 5  $\mu\text{g/L}$  extends approximately 4.5 miles downgradient south-southwest of the former Omega facility to an area located between EPA Wells MW29 and MW30 (Figure 1-4). PCE concentrations exceeding 100  $\mu\text{g/L}$  form a relatively narrow zone that extends from the Omega property to between CENCO Refinery Wells MW603 and MW605. Two distinct zones of concentrations exceeding 500  $\mu\text{g/L}$  are present. One originates at the Omega property and extends into the deeper aquifer zone at Well MW23; the second zone is directly downgradient of the Angeles Chemical and the McKesson Corporation (AMK) sites. These two facilities are adjacent and have documented releases of similar contaminants to groundwater; they are treated as one source area (AMK) in this FS. Other, more localized and much smaller zones of high PCE concentrations present west of AMK are associated with other industrial facilities (Figure 5-11 of the RI report; CH2M HILL, 2010).
- The maximum TCE detection of 2,600  $\mu\text{g/L}$  was found in Well OW1A. The extent and characteristics of the observed TCE plume are similar to those of the PCE plume. TCE concentrations up to 100 times the MCL were found to be associated with the Omega property and AMK. A distinct lobe of TCE concentrations greater than 500  $\mu\text{g/L}$  west of the Omega property is associated with a source area at Whittier Boulevard (Figure 5-12 of the RI report, CH2M HILL 2010). Other, more localized and much smaller zones of high TCE concentrations present west of AMK and generally co-located with zones of high PCE are associated with other industrial facilities (Figure 5-12 of the RI report; CH2M HILL, 2010).
- The maximum Freon 11 detection of 210  $\mu\text{g/L}$  was found in Well OW5. The Freon 11 plume is narrower than PCE or TCE plumes, and it does not extend as far downgradient. No source for Freon 11 other than the former Omega facility has been identified; Freon 11 is, therefore, considered a tracer compound for contamination originating at the Omega property. However, because Freon 11 is present at much lower concentrations than PCE and TCE at OU1 (i.e., the Omega Contaminants source area), its extent in groundwater at OU2 is smaller than the extent of the release of hazardous substances from the Omega property (Figures 5-13 and 5-14 of the RI report; CH2M HILL, 2010).

- The maximum Freon 113 detection of 730 µg/L was found in Well OW8A. The Freon 113 plume extent is similar to the extent of the Freon 11 plume. No source for Freon 113 other than the former Omega facility has been identified; Freon 113 is, therefore, considered a tracer compound for contamination originating at the Omega property. However, because Freon 113 is present at much lower concentrations than PCE and TCE at OU1 (i.e., the source area), its extent in groundwater at OU2 is smaller than the extent of the release of hazardous substances from the Omega property (Figures 5-13 and 5-14 of the RI report; CH2M HILL, 2010).
- The maximum 1,4-dioxane detection of 290 µg/L was found in Well OW1A. The extent of 1,4-dioxane is similar to the extent of PCE and TCE, except that it is wider between Wells MW21 and MW28. The 1,4-dioxane concentrations decrease rapidly downgradient from the Omega property; a separate zone of high concentrations extends from the AMK area (Figure 5-16 of the RI report CH2M HILL, 2010).
- The maximum hexavalent chromium detection of 200 µg/L was found at Well MW8A. The extent of hexavalent chromium does not follow a pattern similar to the VOC plumes; it extends from Well MW1A to the southwest. Historical concentrations near the Omega property have been low, suggesting that the Omega facility is probably not a significant source for hexavalent chromium contamination. Separate zones of concentrations exceeding 50 µg/L extend from the Foss Plating and Phibro-Tech, Inc. facility properties (Figure 5-17 of the RI report; CH2M HILL, 2010).
- Perchlorate contamination was found at low concentrations with the maximum detection of 7.5 µg/L found at Well MW16A. Laterally, the perchlorate contamination is spotty and does not follow a simple pattern. There are three zones of contamination above the MCL for perchlorate (6 µg/L). Sources for perchlorate contamination cannot be easily identified from the available data (Figure 5-18 of the RI report; CH2M HILL, 2010).
- The maximum 1,1-dichloroethene (1,1-DCE) detection of 710 µg/L was found at Well OW1A. The extent of 1,1-DCE in groundwater was found to be similar to that of PCE and TCE, including the relatively high concentrations associated with the Omega property and the AMK area (Figure 5-19 of the RI report; CH2M HILL, 2010).
- The maximum cis-1,2-DCE detection of 300J µg/L (J = estimated) was found at Well MW17A. Three separate zones of cis-1,2-DCE contamination above the MCL (6 µg/L) were identified, indicating the possibility of multiple sources (Figure 5-20 of the RI report; CH2M HILL, 2010).
- The maximum chloroform detection of 170 µg/L was found at Well OW5. Chloroform is present at low concentrations, generally less than 1 µg/L, throughout OU2. The plume extends approximately from Well MW24 to just beyond Well MW23 (Figure 5-21 of the RI report; CH2M HILL, 2010).
- The maximum carbon tetrachloride detection of 4.7 µg/L was found at Well MW2. Detections for carbon tetrachloride extend from the Omega property to Well MW20 (Figure 5-23 of the RI report; CH2M HILL, 2010).

- The maximum 1,1-dichloroethane (1,1-DCA) detection of 170 µg/L was found in Well MW17A. Detections for 1,1-DCA extend from the Omega property to Well MW27. Concentrations decrease quickly downgradient of the Omega property and are much higher at AMK (Figure 5-24 of the RI report; CH2M HILL, 2010).
- The maximum 1,2-dichloroethane (1,2-DCA) detection of 39 µg/L was found at Well OW8A. 1,2-DCA was found at 24 wells extending from OW8A to MW30 (Appendix F-2 of the RI report; CH2M HILL, 2010).
- The maximum 1,1,1-trichloroethane (1,1,1-TCA) detection of 2,200 µg/L was found at well OW1A. Detections of 1,1,1-TCA extend from the Omega property and quickly decrease to Well MW21. High concentrations of 1,1,1-TCA are found at AMK, Site B, and Site C (Figure 5-26 of the RI report; CH2M HILL, 2010).

Several plumes of fuel hydrocarbons found at OU2 are associated with known sources (Figure 5-28 of the RI report; CH2M HILL, 2010). The extent of the fuel hydrocarbons at OU2 is not known in detail.

Among all the COPCs, PCE and TCE have the greatest plume extents with the highest contaminant concentrations. The Freons are considered signature chemicals of the Omega facility, and their plume extents are smaller than those of PCE and TCE. The greater extents of PCE and TCE plumes than those of Freon plumes are attributed to their higher source concentrations relative to the concentrations of Freons (at OU1) and also to the contributions from other sources of PCE and TCE present within OU2.

The known vertical extent of the contamination is up to about 200 feet bgs. Although most of the production wells in the study area draw water primarily from deep portions of the aquifer (from depths greater than 200 feet bgs) and are not currently impacted by groundwater contamination, PCE and other VOC contaminants have been detected historically at five drinking water supply wells that have screens starting at 200 feet bgs (SFS Well #1, and the Golden State Water Company wells Pioneer #1, Pioneer #2, Pioneer #3, and Dace #1). These wells (Figure 1-3) are currently equipped with wellhead treatment units using granular activated carbon (GAC).

## 1.6 Contaminant Fate and Transport

### 1.6.1 Groundwater

The fate and transport of contaminants in groundwater at OU2 is affected by a variety of chemical, physical, and biological processes. Some of the chemical and biological processes are destructive and result in contaminant mass removal from the groundwater. The presence of daughter products of the degradation of 1,1,1-TCA, PCE, and TCE throughout OU2 indicates that these compounds undergo transformation. However, because PCE and TCE are found across OU2, their degradation is slow relative to their migration rate. Of the COPCs, only 1,1,1-TCA breaks down rapidly and does not extend far from its source areas (such as the Omega Site and AMK). The extent of 1,4-dioxane is similar to the extent of PCE and TCE because 1,4-dioxane does not readily degrade in groundwater and was released at OU2 generally at the same source areas as PCE and TCE. Because the quantities of contaminants released into groundwater are not known, the analysis of the contaminant

transport at OU2 is limited. However, the larger extent of the PCE and TCE plumes compared to the smaller extent of the Freon 11 and Freon 113 plumes can be explained by the higher concentrations of PCE and TCE compared to the concentrations of Freon 11 and Freon 113 found at OU1 (indicating greater quantities of PCE and TCE than Freon 11 and Freon 113 were released at the former Omega property) as well as by the presence of other sources of PCE and TCE within OU2.

The extents of the PCE and TCE plumes are greater than the plumes of their degradation products. The degradation products would be expected to be present along with PCE and TCE if the parent compounds degraded in the aquifer. The smaller extent of the daughter products may be an indication that PCE and TCE degrade primarily at the source areas and not farther downgradient, or that the daughter products break down faster than PCE and TCE. It is also noted that the VOC degradation pathways in groundwater are uncertain.

Other contaminant transport mechanisms are nondestructive and only result in redistribution of the contaminant mass between phases, affect contaminant migration rates, and result in contaminant spreading. These processes include volatilization from groundwater into the vapor phase, sorption, diffusion, advection, and dispersion. Phase partitioning (including volatilization and sorption) depends on the properties of individual contaminants, while the remaining processes affect most chemicals similarly.

The contamination from the former Omega facility and AMK has advanced at an apparent plume expansion rate of at least 540 feet per year (ft/y); this rate is an estimated minimum rate and includes the combined effects of advection, sorption, dispersion, and degradation. This plume expansion rate is consistent with estimates of advective velocity of 620 ft/y using methods such as Monte Carlo Simulation and with plume advancement simulated by analytical transport modeling. The main migration pathway starts at the former Omega property and continues generally southwest to near the AMK area, then turns more southerly to the area near Wells MW29 and MW30 (Figure 1-4). Contamination from other source areas within OU2 (e.g., the sources west of AMK) follows a parallel pathway. The contamination from the former Omega facility is commingled with contamination released from multiple other sources, as well.

The numerical modeling results support the conceptual understanding of groundwater flow and contaminant transport at OU2. The Omega model simulated the groundwater flow conditions at OU2 and the development of the PCE plume during the historical period of operations at Omega and AMK. The Omega model simulated the main contaminant transport pathways from Omega and AMK and showed that the simulated contamination from these two source areas has commingled. Other sources of contamination were not represented in the model.

### 1.6.2 Vadose Zone

The potential for the migration of VOC vapors into the vadose zone exists throughout OU2. Because of the expected, predominantly aerobic conditions, little to no degradation of PCE and TCE is expected to occur in the vadose zone; no degradation products of PCE and TCE were found in the soil gas during the RI (CH2M HILL, 2010). The migration rate for the vapor phase contamination in the vadose zone was not quantified; the vapor transport,

however, is fast relative to the transport in groundwater, and steady contaminant mass fluxes in the vapor phase can be assumed at most locations within OU2.

## 1.7 Risk Evaluation

### 1.7.1 Human Health Risk Assessment

As part of the RI (CH2M HILL, 2010), an HHRA was performed to determine if groundwater contamination at OU2 poses a current or potential future risk to human health. This risk assessment presents the first evaluation of human health impacts from the contamination of OU2 groundwater. The HHRA assesses whether a response action is necessary to protect human health and, if so, provides justification for performing a response action and identifying which exposure pathways require mitigation or remediation. The following summarizes the findings from the HHRA.

The HHRA results indicated that the OU2 groundwater does not pose a current or immediate risk to human health due to the absence of a complete exposure pathway. However, the estimated potential future cumulative cancer risk for an individual of  $9 \times 10^{-1}$  (i.e., nine out of ten persons) from exposure to untreated OU2 groundwater used as residential tap water greatly exceeds the cancer risk management range of one-in-a-million ( $1 \times 10^{-6}$  or  $1 \text{E-}06$ ) to one-in-ten thousand ( $1 \times 10^{-4}$  or  $1 \text{E-}04$ ). PCE contributes 98 percent of the cancer risk; all of the other COPCs each contribute less than 0.5 percent of the cancer risk. In addition to PCE, the following are primary contributors to cancer risks for all routes of exposure associated with tap water use and each poses a cancer risk of at least  $1 \times 10^{-3}$  (one in 1,000): 1,2-DCA, 1,4-dioxane, chloroform, 1,2-dibromo-3-chloropropane, TCE, 1,1,2-TCA, and arsenic

The estimated potential future cumulative health hazard index (HI) for child receptors is 3,236. The potential for adverse health effects exists when the HI exceeds 1. PCE and TCE are the primary contributors to HI for all three routes of exposure (i.e., ingestion, inhalation, and dermal contact) and contribute 84 percent and 10 percent of the overall HI, respectively.

The HHRA also evaluated the potential risk from inhalation of VOC vapors off-gassing from contaminated groundwater at OU2. Inhalation exposure due to soil gas vapor intrusion into indoor air currently does not pose significant risk to the residents of Whispering Fountains Apartments, a residential complex southwest of OU1 that was identified as a potential area of concern for indoor air VOC vapor intrusion due to relatively shallow depth-to-groundwater (compared to other areas of OU2) and high VOC concentrations in groundwater in that area. The estimated cancer risks are less than  $1 \times 10^{-6}$  and range from  $3 \times 10^{-8}$  to  $3 \times 10^{-7}$ . The HI is significantly less than 1. The HHRA did not evaluate potential risks associated with vapor intrusion for the approximately 20 source areas at OU2 where VOC contamination is present in the vadose zone (CH2M HILL, 2010).

### 1.7.2 Ecological Risk Assessment

There is no risk to ecological receptors from contaminants in groundwater at OU1 and OU2 (CH2M HILL, 2010). All surface water runoff at OU2 drains over into concrete-lined washes and drains where there is no potential for contact with contaminated groundwater because the drains are above the water table.

Ornamental trees and small areas of landscaped grass represent extremely limited habitat and a very limited diversity of ecological receptors throughout OU2 and OU1. One small urban park within OU2 and two urban parks adjacent to the OU2 boundary offer recreation areas for residents but provide little habitat for wildlife.

Although VOC vapors have been detected in buildings near the surface of OU1 and therefore might also impact animal burrows, no burrowing birds or mammals occupy OU1 due to the lack of suitable habitats.

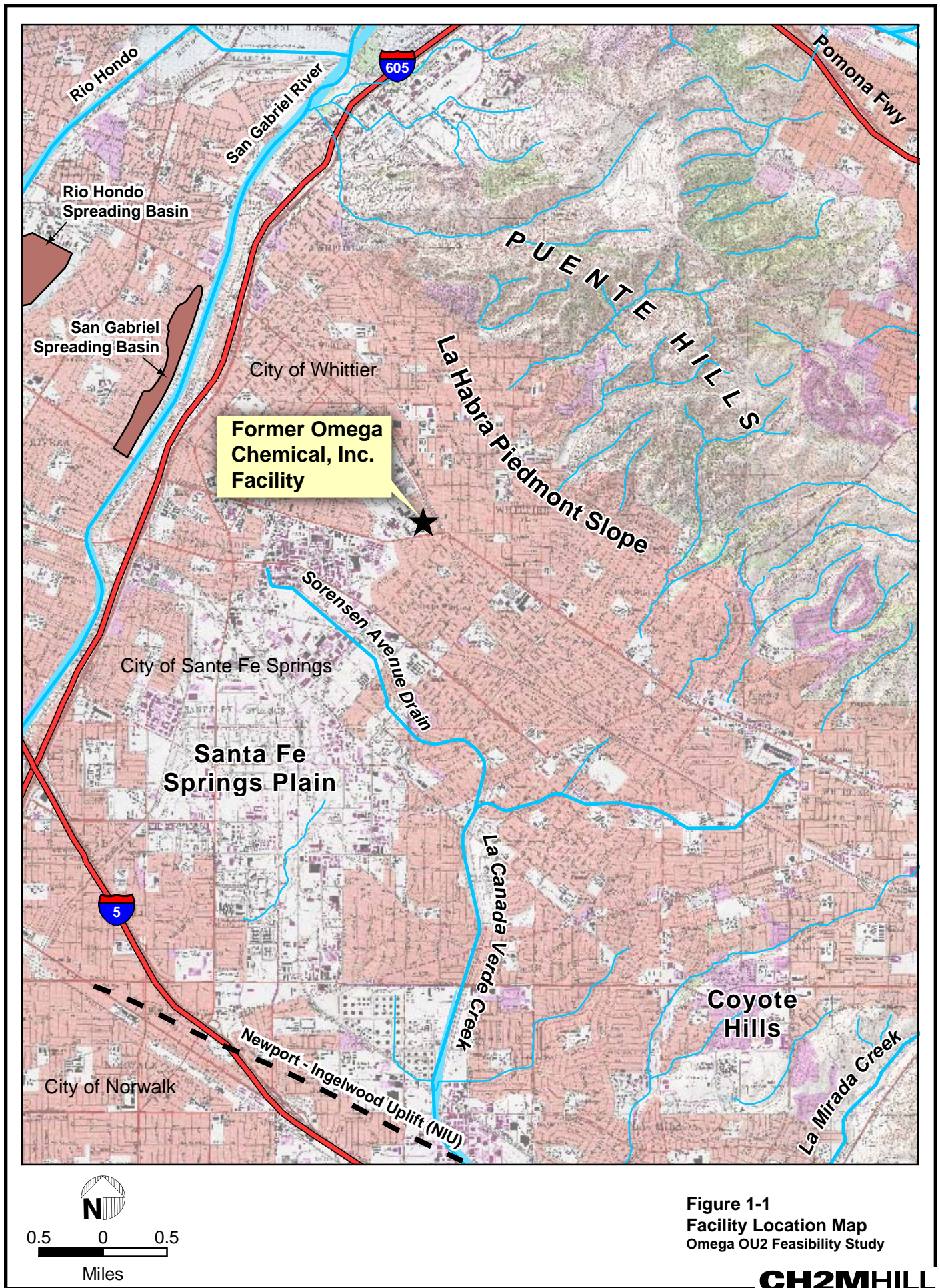
In conclusion, there are no complete exposure pathways between contaminants and receptors and no potential for risk to ecological receptors at the Omega Site.

### **1.7.3 Conclusions of the Risk Assessment**

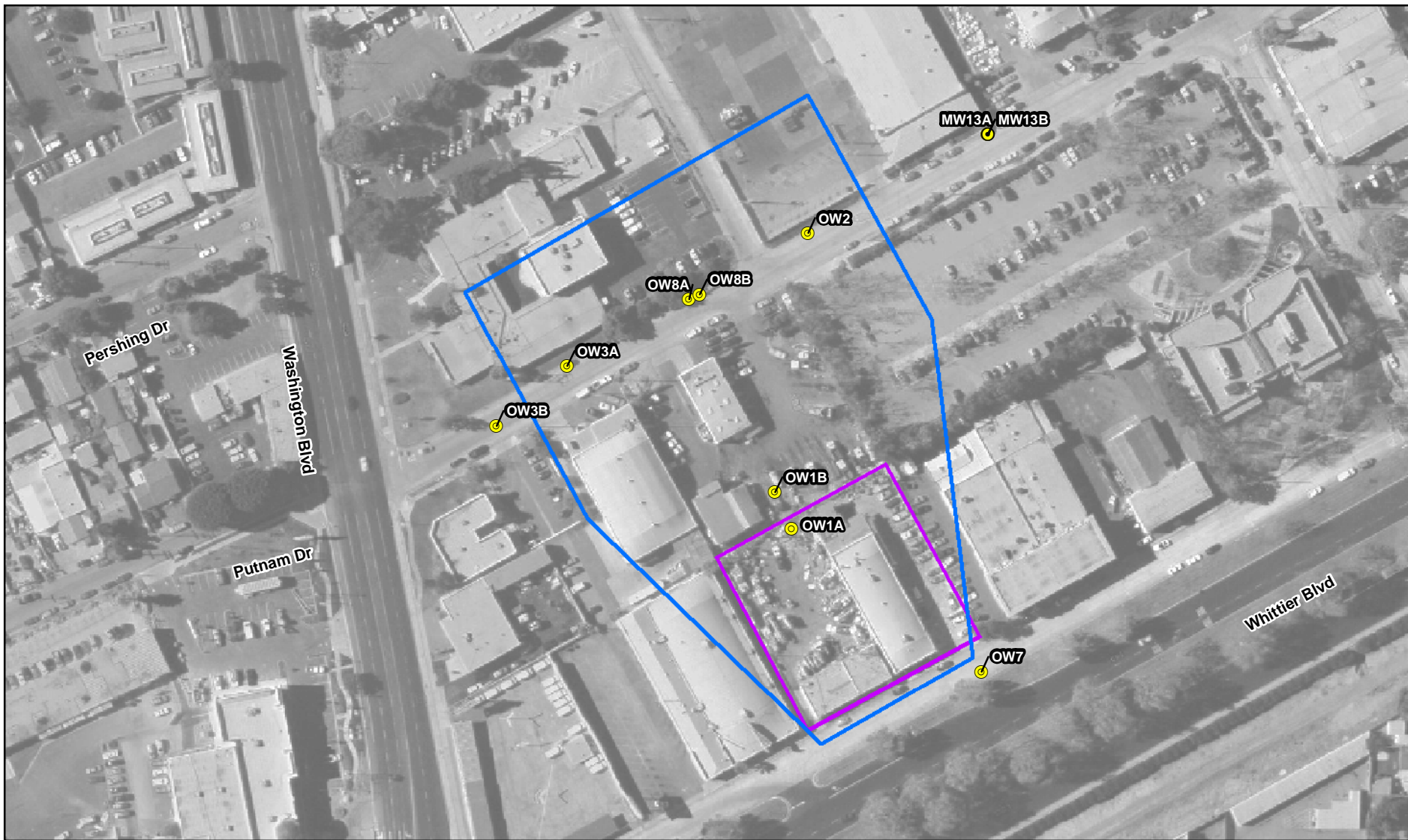
Results of the OU2 HHRA confirm that groundwater resources have been significantly contaminated by VOCs in OU2. The OU2 groundwater is unsuitable as a source of tap water for domestic use without treatment. Although most of the production wells at and near OU2 draw water primarily from deep portions of the aquifer (from depths greater than 200 feet bgs), PCE and other contaminants have historically been detected at several drinking water supply wells (e.g., City of Santa Fe Springs Production Well #1, and the Golden State Water Company wells Pioneer #1, Pioneer #2, Pioneer #3, and Dace #1). As a result, all of these municipal water supply wells are currently equipped with wellhead treatment units. In addition, due to the induced downward gradient, there is potential for the contaminated groundwater currently residing in the shallow aquifer to migrate into the deep portion of the aquifer if not mitigated.

Inhalation exposure due to soil gas vapor intrusion into indoor air does not pose significant risk to the residents of Whispering Fountains Apartments. No further action is warranted at Whispering Fountains Apartments or other residential areas within OU2 because VOC volatilization from groundwater is not expected to pose a significant risk at OU2. This recommendation does not necessarily apply to the various source areas at OU2 because they were not part of this HHRA (CH2M HILL, 2010) to determine whether exposure risks to occupants and workers may exist due to the presence of contamination in the shallow subsurface.









Aerial Date: March 2004, USGS

# Legend

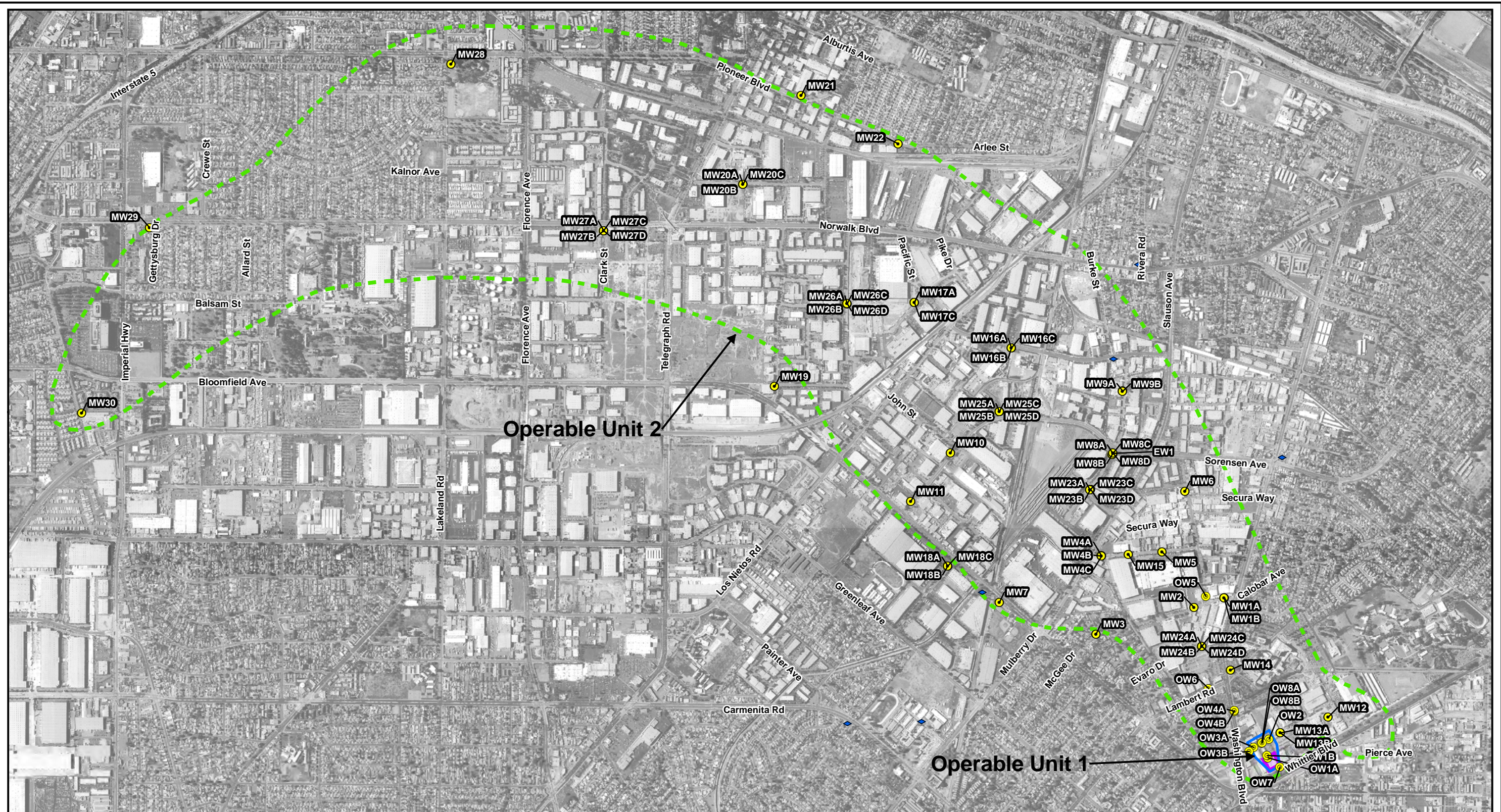
- Former Omega Facility
- Operable Unit 1

- EPA Monitoring Well
- Omega Potentially Responsible Parties Organized Group (OPOG) Monitoring Well



**Figure 1-2**  
**Location Map for Operable Unit 1**  
 Omega Chemical Superfund Site





Aerial Date: March 2004, USGS

### Legend

- Operable Unit 1
- Operable Unit 2
- Former Omega Facility
- EPA Monitoring Well
- Omega Potentially Responsible Parties Organized Group (OPOG) Monitoring Well
- ◆ Active Production Well (Locations shown are approximate)



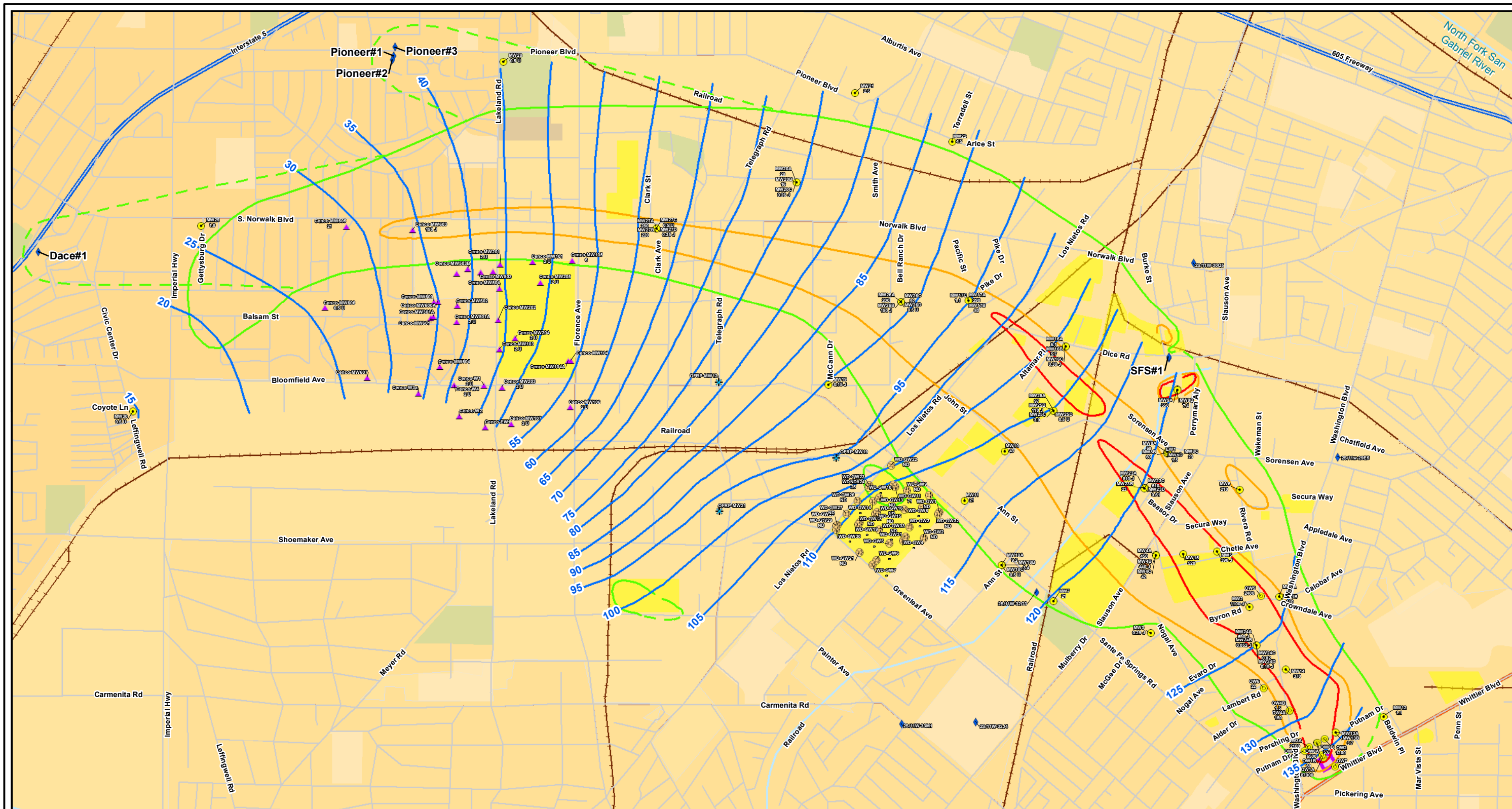
0 1,600 3,200 Feet

**Figure 1-3**  
**Location Map for Operable**  
**Units 1 and 2**  
 Omega Chemical Superfund Site  
 Omega OU2 Feasibility Study



Date: January 8, 2010





# Legend

- EPA Monitoring Well (July 2007)
- Omega Potentially Responsible Parties Organized Group (OPOG) Monitoring Well (August 2007)
- Oil Field Reclamation Project (OFRP) Well
- Waste Disposal, Inc. (WDI) Well (4th Quarter, 2002)

- Active Production Well (Locations shown are approximate)
- CENCO Wells (August - November 2006)
- Approximate Boundary of Facilities
- Former Omega Facility

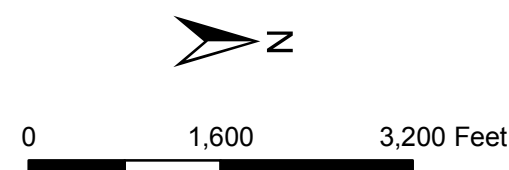
## Composite PCE Plume Extent, July 2007

- 5 ug/L
- 100 ug/L
- 500 ug/L
- Potential deep (about 200 feet below ground surface) PCE extent
- Water Level Contours 2007

Notes: 1) J - Estimated Value upper level of instrument calibration range. 2) U - Non-Detect 3) E - Estimated value as the concentration exceed upper level of instrument calibration range. 4) NS - Not Sampled

\\GALT\PROJ\OMEGA\2010\MAPFILES\11X17\_PCE\_V2.MXD DDODS

**Figure 1-4**  
**Composite PCE Distribution**  
Omega OU2 Feasibility Study



CH2MHILL

Date: May 5, 2010



## 2. Identification and Screening of Technologies

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### 2.1 Introduction

This section describes the RAOs for the remedial alternatives developed and evaluated in Sections 3 and 4, and the potential ARARs. This section also identifies and describes GRAs that are likely to achieve the RAOs. Remedial technologies that can be used to implement the GRAs are also identified and screened.

### 2.2 Remedial Action Objectives

RAOs are narrative statements that define the goals for protecting human health and the environment. For the purpose of this FS, the RAOs address Contaminants of Concern (COCs) (i.e., groundwater contamination within OU2 and exclude contamination contained by the OU1 interim groundwater remedy). The COCs are summarized in Table 2-1. For the purpose of this FS, the COCs are all chemicals found at concentrations exceeding their screening levels in Omega wells (Table 5-5 of the RI report; CH2M HILL, 2010) but excluding OU1 source area wells OW1A, OW1B, OW2, OW3A, OW3B, OW8A, and OW8B. In addition, Table 2-1 includes a range of detected concentrations that reflects all historical data since 1996 through July 2007. The COCs may have originated from the hazardous substances released at the former Omega facility and/or from other known and unknown sources. Some of these compounds may be naturally occurring. Treatment of these chemicals may be required for the OU2 groundwater remedy.

RAOs take into consideration the COCs, exposure routes and receptors, and acceptable contaminant levels for each contaminated medium (e.g., groundwater).

#### 2.2.1 Development of Remedial Action Objectives

RAOs consist of medium-specific or operable unit-specific goals for protecting human health and the environment. The RAOs aimed at protecting human health and the environment should specify the following:

- The COCs and the media in which they are present
- Exposure route(s) and receptor(s)
- Acceptable contaminant levels for each exposure route based on the HHRA

The following are the RAOs developed for the interim containment remedy for Omega OU2:

1. Prevent unacceptable human exposure to groundwater contaminated by COCs
2. Decrease lateral and vertical spreading of COCs in groundwater at OU2 to protect current and future uses of groundwater

3. Decrease lateral and vertical migration of groundwater with high concentrations of COCs into zones with currently lower concentrations of COCs to optimize the efficiency of contaminant mass removal and treatment of extracted groundwater

## 2.3 Applicable or Relevant and Appropriate Requirements

Under CERCLA, a remedial action must achieve ARARs, unless a waiver is granted. The ARARs can be defined as standards, requirements, criteria or limitations under federal (or if more stringent, state) environmental laws as they relate to onsite remedial actions. In the context of this FS, “onsite” includes the areal extent of OU2 contamination and all suitable areas near the OU2 contamination necessary for implementation of the response action at the Omega OU2 (40 *Code of Federal Regulations* [CFR] §300.5). Onsite actions must comply with the substantive aspects of ARARs. Offsite actions must comply with all applicable local, state, and federal requirements.

In some situations, ARARs may not be available or adequately address protection of human health and the environment. Where ARARs do not sufficiently address a situation, to-be-considered (TBC) criteria (e.g., nonpromulgated advisories, criteria, guidance, or proposed standards) issued by federal and state agencies can be used to define cleanup and/or performance standards (40 CFR §300.400[g][3]). These TBC criteria are not ARARs; they are not enforceable, nor are they legally binding, unless that TBC criterion is adopted as a cleanup or performance standard in the Record of Decision (ROD). However, these criteria are considered when developing cleanup levels.

The ARARs, in conjunction with the overall protection of human health and the environment criterion, form the threshold criteria to evaluate remedial alternatives when selecting a remedial action. The final determination of ARARs will not be made until the remedy for Omega OU2 is selected and documented in a ROD; therefore, the ARARs and TBCs identified herein are preliminary.

### 2.3.1 ARARs Definition

ARARs are defined in CERCLA to include the following:

- Any standard, requirement, criterion, or limitation under federal environmental law
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation

An ARAR may be either “applicable” or “relevant and appropriate.” These terms are defined in the National Oil and Hazardous Substances Pollution Contingency Plan (referred to as the National Contingency Plan [NCP]) (40 CFR §300.5) as follows:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at the CERCLA site.

- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.

The potential ARARs in this document represent the most stringent of the state and federal requirements. When considering substantive state requirements, only those promulgated state requirements that are identified by the state in a timely manner and that are more stringent than federal requirements are considered ARARs (CERCLA §121[d][2][A][ii]).

Stringency criteria are applied to the state requirements prior to identification as potential ARARs in this document. For example, the state identified the California Environmental Quality Act (CEQA) as an ARAR (State Water Resources Control Board [SWRCB], 1992; RWQCB 2002). CEQA is an informational document used by California public agencies in the decision making process with requirements that are no more stringent than the environmental review conducted through CERCLA. Prescribed CERCLA procedures for evaluating environmental impacts include selecting remedial action with feasible mitigation measures, providing for public participation and review, and evaluating short- and long-term impacts to human health, procedures that are substantially equivalent to the CEQA requirements. Because the state and federal requirements through CERCLA are no less stringent than CEQA requirements, EPA has determined that CEQA is not an ARAR.

State agencies have published or provided state requirements relevant to their agency jurisdiction (SWRCB, 1992; RWQCB, 2002). The application of these requirements to Omega OU2 is also evaluated. Although nonenvironmental laws are not discussed as ARARs, including worker safety laws, the hazardous waste worker safety regulations are acknowledged as part of any onsite remedial activity. The remedial activity selected for the site is anticipated to conform to the California worker safety regulations for Hazardous Waste Operations and Emergency Response [HAZWOPER] (Title 8, California Code of Regulations [CCR] §5192 *et seq.*). Employee safety requirements are provided for cleanup operations or hazardous substance removal work required by a governmental body. The California regulations have incorporated the HAZWOPER requirements (29 CFR §1910.120 *et seq.*) and are considered more stringent than federal requirements. Additionally, any offsite activity must comply with all applicable substantive and administrative regulatory requirements.

### 2.3.2 ARAR Waiver Provisions

Specific circumstances in which ARARs may be legally waived are established in CERCLA (CERCLA §121[d][4]). Six waiver criteria are available (i.e., interim measures, greater risk to health and the environment, technical impracticability, equivalent standard of performance, inconsistent application of state requirements, and fund balancing). Under any of the following criteria and circumstances, a remedial action may be selected despite not attaining an ARAR:

- **Interim Measure** – The remedial action selected is only a part of the total remedial action that will attain such level or standard of control when completed.

- **Greater Risk to Health and the Environment** – Compliance with the requirement will result in greater risk to human health and the environment than alternative operations.
- **Technical Impracticability** – Compliance with the requirement is technically impracticable from an engineering perspective.
- **Equivalent Standard of Performance** – The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation, through use of another method or approach.
- **Inconsistent Application of State Requirements** – With respect to state standards, requirements, criteria, or limitations, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criterion, or limitation in similar circumstances at other remedial actions within the state.
- **Fund Balancing** – In case of a remedial action to be undertaken solely under CERCLA §104 using the Hazardous Substance Response Fund, selection of a remedial action that attains such level or standards of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration, taking into consideration the relative immediacy of such threats.

### 2.3.3 Site-Specific ARARs

The identification and documentation of potential ARARs was accomplished using EPA guidance in conjunction with a review of federal and state laws, regulations, and policies (EPA 1988).

The identified potential ARARs for Omega OU2 are presented in Table 2-2. This table provides rationale for the decision that a specific requirement is applicable or relevant and appropriate for a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at Omega OU2. Potential ARARs are presented in three categories based on the manner in which they are applied to Omega OU2: chemical-, location-, and action-specific ARARs. Within the three categories, the requirements are further organized by federal ARARs, followed by state ARARs. The TBCs are presented in Table 2-2A. A description of categories, followed by the principal requirements within each category, is provided as follows. Furthermore, only those standards and regulations that are considered ARARs are addressed.

#### 2.3.3.1 Chemical-Specific Requirements

Potential chemical-specific ARARs are health- or risk-based concentration limits, numerical values, or methodologies for various environmental media (e.g., groundwater, soil, and soil vapor) and establish the acceptable amount or concentration of a chemical that may be found in or discharged to the environment. Chemical-specific requirements are available and are presented for the contaminated aquifer.

#### Federal Chemical-Specific ARARs

**Federal Primary Drinking Water Standards (40 CFR Part 141).** Federal primary maximum contaminant levels (MCLs) under the Safe Drinking Water Act (SDWA) (2 United States Code [U.S.C.] §§ 300, et seq.) protect the public from contaminants that may be found in

drinking water. The MCLs are only applicable “at the tap” for drinking water provided to 25 or more people or water systems with 15 or more service connections. Because groundwater underlying Omega OU2 is identified by the state as a potential source of drinking water, the requirements are relevant and appropriate to the aquifer underlying Omega OU2. The federal MCLs for the COCs are presented in Table 2-1.

### **State Chemical-Specific ARARs**

**California Toxics Rule (CTR).** This establishes water quality criteria for surface water, typically implemented through the federal NPDES permit program. These standards may be applicable for discharge of treated groundwater to surface water.

**Primary Drinking Water Standards (22 CCR §64431 and 64444).** California has promulgated drinking water standards for public drinking water sources under the California Safe Drinking Water Act (California Health and Safety Code [H&S C] §4010 et seq.). The Act establishes California primary MCLs to protect public health from contaminants that may be found in drinking water sources.

For some of the COCs, the California MCLs are more stringent than the federal requirements. In those cases when California MCLs are more stringent than federal MCLs, then California MCLs supersede the federal MCLs. The California MCLs identified as ARARs for the COCs are presented in Table 2-1.

**Water Quality Control Plan for Los Angeles Region.** The Water Quality Control Plan for the Los Angeles Region (Basin Plan, adopted June 13, 1994), adopted pursuant to California Water Code Sections 13240 et seq., contains numerical and narrative water quality objectives for waters of the state that ensure protection of beneficial uses and prevention of nuisances affecting beneficial use. These objectives are not merely restricted to surface water but also apply to groundwater (SWRCB 1992). Promulgated numerical water quality objectives may be chemical-specific ARARs. Nonpromulgated mechanisms or theories on how to derive a numerical water quality objective or meet a numerical water quality goal may also be ARARs, if specific regulations are promulgated implementing the goal (55 FR 8746, March 8, 1990).

The numerical water quality objectives for groundwater supply used as a domestic or municipal supply (MUN) are based on drinking water standards. Because the primary MCLs have already been identified as potential ARARs for the COCs at Omega OU2, the numerical water quality objectives in the Basin Plan are addressed through the primary MCLs as chemical-specific ARARs.

Similarly, the RWQCB narrative water quality objectives for groundwater are addressed through the primary MCLs. The narrative water quality objectives establish that “groundwater shall not contain concentrations of chemical constituents or radionuclides in excess of the limits specified in the following provisions (California drinking water regulations).” The groundwater under Omega OU2 has been designated as a beneficial use for a drinking water source pursuant to the drinking water policy of the State Water Board; Omega OU2 has the potential to impact groundwater that is used as a drinking water source.

**SWRCB Resolution No. 92-49.** The Policy and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code §13304 derives its authority to maintain the

highest quality of water (State Water Resources Control Board [SWRCB] Resolution No. 68-16) through waste discharge requirements as implemented through the federal NPDES or RWQCB waste management and discharge requirements (27 CCR §20200 *et seq.*).

The only substantive requirement is identified in SWRCB Resolution No. 92-49, Section III.G. The section requires cleanup to either background water quality, or the best water quality that is reasonable if background cannot be restored. A selected alternative cleanup level greater than chemical background concentration for the aquifer would have to be consistent with maximum benefit to the public and to the present and anticipated future beneficial uses, as well as conform to water quality control plans and policies.

### **2.3.3.2 Location-Specific ARARs**

Potential location-specific ARARs are substantive restrictions placed on the chemical contaminant or the remedial activities based on the geographic or ecological features of Omega OU2. Examples of location-specific features include floodplains, seismic faults, wetlands, historic places, and sensitive ecosystems or habitats.

#### **Federal Location-Specific Requirements**

**National Historic Preservation Act (16 U.S.C. §470 *et seq.*)**. The requirements of the National Historic Preservation Act are applicable to Omega OU2 if the remedy impacts any historic site protected under the act. This requirement may be identified as an ARAR, and further evaluation of this ARAR may be necessary.

#### **State Location-Specific Requirements**

**Hazardous Waste Seismic Consideration (22 CCR §66264.18.a)**. This requirement applies to portions of new hazardous waste facilities where treatment, storage, or disposal of hazardous waste will be conducted. The affected areas must not be located within 61 meters (200 feet) of a fault that has had displacement in Holocene time. Active and nonactive faults may be identified within 200 feet of remedial facilities for Omega OU2. This requirement may be identified as an ARAR, and further evaluation of this ARAR for seismic considerations may be necessary.

**Fish and Game Code §3800**. This section prohibits the take of nongame birds, except in accordance with regulations of the commission, or when related to mining operations with a mitigation plan approved by the department. This section further provides requirements concerning mitigation plans related to mining. This section is applicable to the extent that nongame birds or their eggs are located on or near Omega OU2.

### **2.3.3.3 Action-Specific ARARs**

Potential action-specific ARARs are usually technology- or activity-based requirements for remedial activities. The action-specific ARARs presented are intended to address the remedial alternatives being evaluated.

#### **Federal Action-Specific ARARs**

**Federal Clean Water Act National Pollutant Discharge Elimination System Clean Water Act §402 *et seq.*** The NPDES requirements are applied to point and nonpoint discharge sources. Substantive requirements include the establishment of discharge limitations, monitoring requirements, and best management practices (BMPs) for surface water discharges. The

NPDES requirements are applicable to the control of contaminants to stormwater runoff from a treatment plant construction site and groundwater treatment systems.

**40 CFR §122.26.** Nonpoint sources address using BMPs for control of contaminants to stormwater runoff from construction activities. SWRCB has established requirements for general construction activities, including clearing, grading, excavation, reconstruction, and dredge and fill activities. This section regulates pollutants in stormwater discharge from hazardous waste treatment plants, landfills, land application sites, and spent dumps. This requirement may be identified as an ARAR, and further evaluation of this ARAR may be necessary.

**40 CFR Part 403 and POTW Requirements.** Alternatives that include groundwater disposal at an offsite wastewater treatment facility must meet pretreatment requirements. Effluent discharged to sanitary sewers and Publicly Owned Treatment Works (POTWs) is regulated by municipalities through the NPDES Program. This section prevents pass-through, interference, violations of prohibitions, and violation of local limits. This requirement would be applicable to wastewater (e.g., washwater, brines, etc.) discharge from a treatment plant to a POTW.

In addition, brine discharge to sanitary sewer will need to comply with any requirements set forth by the current POTW owner. Discharges to POTW are also subject to pretreatment requirements, which enable the POTWs to comply with their NPDES permit limits.

### State Action-Specific ARARs

**Water Quality Control Plan.** The RWQCB has developed and adopted the regional water quality control plan (Basin Plan) to protect waters of beneficial use fulfilling the legal requirements of the California Water Code. While the water quality objectives (WQOs) vary for the water bodies affected, the objectives may be applicable for discharges to surface water or land.

**Water Quality Control Plan for Los Angeles Region (adopted June 13, 1994) California Water Code §13240 et seq.** The Basin Plan presents numerical and narrative WQOs for maintaining a high quality of protection for the inland surface water and groundwater in the region. Groundwater underlying the Omega Site has been identified by the Basin Plan as a potential drinking water aquifer. Groundwater and surface water WQOs are provided for contaminants including bacteria, chemicals, radioactivity, minerals, nitrogen, taste, and odor. The groundwater WQOs for the COCs at Omega OU2 are based on primary MCLs. Additional WQOs are provided for surface water. The requirement is relevant to alternatives evaluating treated groundwater reinjection to the aquifer and applicable to alternatives evaluating discharge of treated groundwater to surface water.

**Porter-Cologne Water Quality Control Act (California Water Code).** The following Porter-Cologne Water Quality Control Act and implementing regulations have been reviewed for applicability.

- **California Water Code §13140 – 13147, 13172, 13260, 13263, 132267, 13304, 27 CCR §20090** – Actions taken by public agencies for cleanup of nonhazardous releases are exempt from 27 CCR Div. 2, Subdiv. 1 provided the contaminated materials removed from the immediate place of release shall be discharged according to 27 CCR Div. 2, Subdiv. 1, Chap. 3, Subchap. 2, Art. 2. Remedial actions intended to contain such wastes

at the place of release shall implement applicable SWRCB-promulgated provisions of this division to the extent feasible. These requirements may be applicable to a containment remedy.

- **California Water Code §13140 – 13147, 13172, 13260, 13263, 132267, 13304, 27 CCR Div. 2, Subdiv. 1, Chap. 3, Subchap. 2, Art. 2** – Wastes classified as a threat to water quality (designated waste) may be discharged to a Class I hazardous waste or Class II designated waste management unit. Nonhazardous solid waste may be discharged to a Class I, II, or III waste management unit. Inert waste is not required to be discharged into a SWRCB-classified waste management unit (27 CCR §20200 et seq.). The requirement is relevant because CERCLA waste may be generated as a result of investigation-derived waste and would be disposed at an EPA Region 9-approved facility, in accordance with CERCLA.

**Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California.** Policy for implementing criteria for priority toxic pollutants contained in the California Toxics Rule promulgated by EPA, as well as other priority toxic pollutant criteria and objectives. Criteria are implemented through the NPDES permit process. This section is applicable to discharges of treated groundwater to surface water.

**Concentration Limits 27 CCR §20400.** Concentration limits must be established for groundwater, surface water, and the unsaturated zone. The limits must be based on background, equal to background, or for corrective actions, may be greater than background, not to exceed the lower of the applicable water quality objective or the concentration technologically or economically achievable. Specific factors must be considered in setting cleanup standards above background levels. The specific factors have been addressed in SWRCB Resolution No. 92-49. These requirements are relevant and appropriate.

**Compliance Period 27 CCR §20410.** Requires monitoring for compliance with remedial action objectives for a specified number of years from the date of achieving cleanup standards. These requirements are relevant and appropriate.

**General Water Quality Monitoring and Systems Requirements 27 CCR §20415.** Requires general soil, surface water, and groundwater monitoring. Applies to all areas at which waste is discharged to land. These requirements are applicable.

**Water Code §13140, 40 CFR §131.12 Maintaining High Quality Water in California SWRCB Resolution No. 68-16.** SWRCB Resolution No. 68-16 requires maintenance of existing state water quality using best practicable treatment technology unless a demonstrated change will benefit the people of California, will not unreasonably affect present or potential uses, and will not result in water quality less than that prescribed in other state policies. The policy derives its authority to maintain the highest quality of water through waste discharge regulations to surface water and land implemented through the federal NPDES or California's Discharges of Waste to Land (27 CCR Division 2, Chapter 3), respectively.

This code applies to the discharge of waste to waters, including alternatives that include reinjection into the aquifer and discharges that may affect surface water or groundwater. In situ cleanup levels for contaminated groundwaters must be set at background level, unless otherwise allowed. If degradation of waters is allowed to remain, the discharge must meet

best practical treatment or control standards; and result in the highest water quality possible that is consistent with the maximum benefit to the people of the state. WQOs may not be exceeded in any case. These requirements are applicable.

**California Hazardous Waste Laws.** On July 26, 1982, the federal RCRA requirements were promulgated. California received EPA authorization to administer and implement a state hazardous waste management program that is more stringent than the federal RCRA program. Authorization to enforce the federal requirements is received only after the RCRA requirements are incorporated into California's hazardous waste regulations. Those portions of the RCRA program presented in this report have received authorization by EPA and have been incorporated into California regulations. The California Hazardous Waste Control Law, Chapter 6.5 of Division 20 of the California H&S Cs, and the regulations of Title 22 CCR are therefore referenced in this report in lieu of federal RCRA provisions.

The two methods for characterizing hazardous waste are (1) RCRA-listed (i.e., source and nonsource specific) and (2) by characteristics (i.e., ignitability, corrosivity, reactivity, and toxicity). For CERCLA actions that involve treatment, storage, or disposal of hazardous waste after July 26, 1982, the hazardous waste standards are generally applicable. If federal hazardous waste was treated, stored, or disposed at the Omega Site before the effective date of these standards, the standards would be relevant and appropriate (EPA 1988).

Considering the time frame of former Omega facility operations, contaminants, and characteristics, there is sufficient information to classify the COCs in the groundwater as characteristic hazardous waste. The specific hazardous waste requirements that may be relevant and appropriate (i.e., an ARAR) to the Site are discussed in the comprehensive tabular summary of ARARs (Table 2-2).

**SWRCB Resolution No. 88-63.** The SWRCB resolution "Sources of Drinking Water" designates, with certain exceptions, all groundwater and surface waters in the state as municipal or domestic water supply sources. This resolution is also incorporated into the Basin Plan. Because SWRCB Resolutions No. 68-16 and 92-49 focus on the protection of groundwater for beneficial uses, the definition of drinking water sources is an important consideration for this site.

For groundwater below the Omega Site, an aquifer would be considered suitable or potentially suitable as a municipal or domestic water supply with the exception of water sources that exhibit the following characteristics:

- Yield water with the total dissolved solids (TDS) exceeding 3,000 milligrams per liter (mg/L)
- Contain natural or anthropogenic contaminated water that cannot be reasonably treated for domestic use using either BMPs or best economically achievable treatment practices
- Are not capable of sustaining 200 gallons per day (gpd) through a single well

These exceptions are not satisfied for the groundwater at OU2. The groundwater located beneath the Site is not known to discharge to surface water. It is an aquifer with potential for contaminants to migrate to aquifers used for municipal and domestic drinking water supply. Therefore, SWRCB Resolution No. 88-63 is applicable (i.e., an ARAR) to the Site; and

the aquifer will be treated as a potential source of drinking water for protection under SWRCB Resolutions No. 68-16 and 92-49.

**Remediation of Pollution: State Board Resolution No. 68-16; State Board Resolution No. 92-49; California Code of Regulations, Title 23, Chapter 15, Article 5.** The “Statement of Policy with Respect to Maintaining High Quality of Waters in California” (Resolution 68-16) is the state’s anti-degradation policy, which provides a narrative standard requiring that high-quality surface water and groundwater be maintained to the maximum extent possible.

Any waste discharge to existing high-quality waters will be required to meet waste discharge requirements that will result in best practical treatment technology, ensuring that a pollution or nuisance will not occur and that the highest water quality consistent with maximum benefit to the people of the state will be maintained. Determination is made through a two-step process to determine (1) whether further degradation may be allowed and (2) the discharge level that will result in the best practicable treatment or control of the discharge.

Resolution No. 68-16 is an action-specific ARAR applicable to remedial alternatives that include surface water discharges, ponding basins, or groundwater reinjection, and to treatment technologies with active discharges to surface water or groundwater.

Anti-degradation requirements apply prospectively and obligate EPA to prevent further degradation of the water during and at completion of the cleanup action (EPA, 1990).

Ground water treatment system effluent will be monitored to ensure that surface and ground water quality will be maintained to the maximum extent possible.

Groundwater reinjection is a potential option for the disposal of treated groundwater at Omega OU2. EPA’s position is that only COCs identified for Omega OU2 shall be treated. Treated groundwater injected within the footprint of a contaminated plume will be treated to at least the concentration level in the groundwater at the point of reinjection, but not greater than the drinking water standard. Reinjection outside the contaminated plume must be less than the MCL standard at which the discharger can be expected to achieve using reasonable control measures at the point of reinjection (EPA, 1993).

**Water Quality Monitoring and Response Programs for Solid Waste Management Units (27 CCR §20385 et seq.).** The monitoring requirements apply to all determinations of alternative cleanup levels for unpermitted discharges to land of solid waste, pursuant to SWRCB Resolution No. 92-49, Section III.G. The provisions of the Detection, Evaluation, and Corrective Action monitoring requirements were developed for the purposes of detecting, characterizing, and responding to releases to groundwater, surface water, or the unsaturated vadose zone. Because the Omega Site has not yet completed the Superfund process through the RI/FS phase, the detection and characterization monitoring requirements are relevant to Omega OU2. However, corrective action monitoring to demonstrate completion of the selected interim remedy for groundwater treatment at Omega OU2 would be relevant and appropriate (i.e., an ARAR) and is further discussed in Corrective Action Program (27 CCR §20430).

**Corrective Action Program (27 CCR §20430).** Corrective action measures taken (e.g., groundwater pump-and-treat system) may be terminated when the discharger

demonstrates that all the COC concentrations have been reduced to levels below their respective concentration limits throughout the entire zone affected by the release. Completion of the correction action for the treatment system(s) is demonstrated using the following criteria and requirements:

- The concentration of each COC in each sample from each monitoring point in the Corrective Action Program for the unit must have remained at or below its respective concentration limit during a proof period of at least 1 year, beginning immediately after the suspension of corrective action measures.
- The individual sampling events for each monitoring point must have been evenly distributed throughout the proof period and have consisted of no less than eight sampling events per year per monitoring point.

The schedule to demonstrate compliance for corrective action appears relevant and appropriate (i.e., an ARAR).

***South Coast Air Quality Management District Rules and Regulations.*** In California, the authority for enforcing the standards established under the Clean Air Act has been delegated to the state. To implement the federal Clean Air Act, states are required to submit and adopt a state implementation plan (SIP) for EPA approval. The SIP addresses implementation, maintenance, and enforcement of the national and California ambient air quality standards (AAQs). A significant component of the SIP is the inclusion of local air pollution district regulations and rules, which are used to control emissions and attain these AAQs. Federal approval resulted in the SIP being federally enforceable and considered a potential ARAR for Omega OU2 response actions. Accordingly, the South Coast Air Quality Management District (SCAQMD) rules and regulations addressed in this SIP establish the local air pollution control requirements for Los Angeles, Orange, and portions of Riverside and San Bernardino counties, including the following:

- Regulation IV, Rule 401, Visible Emissions – Discharge of any contaminant into the atmosphere from any single source of emission shall not be as dark or darker than shade No. 1 on the Ringelmann Chart or of such opacity that may obscure an observer's view to a degree equal to or greater than shade No. 1 on the Ringelmann Chart. This rule is a potential ARAR.
- Regulation IV, Rule 402, Nuisance – Discharge from any source shall not contain air contaminants or other material, which causes injury, detriment, nuisance, or annoyance to any considerable number of persons, or to the public. Discharge shall also not endanger the comfort, repose, health, or safety of any such persons or the public, or cause injury or damage to business or property. This rule is a potential ARAR.
- Regulation IV, Rule 403, Fugitive Dust – The intention of Rule 403 is to reduce, prevent, or mitigate emission of fugitive dusts from any activity or man-made condition capable of generating fugitive dust. Emissions of fugitive dust shall not remain visible in the atmosphere beyond the property line of the emission source. Activities conducted in the South Coast Air Basin shall use best available control measures to minimize fugitive dust emissions and take necessary steps to prevent the track-out of bulk material onto public paved roadways as a result of their operations. This rule is a potential ARAR.

- Regulation IV, Rule 404, Particulate Matter Concentration – Particulate matter in excess of the concentration standard shall not be discharged from any source. Particulate matter in excess of 450 milligrams per cubic meter (0.196 grain per cubic foot) in discharged gas, calculated as dry gas at standard conditions, shall not be discharged to the atmosphere from any source. Emissions shall be averaged over one complete cycle of operation or 1 hour, whichever is the lesser time. This rule is a potential ARAR.
- Regulation IV, Rule 405, Solid Particulate Matter-Weight – Solid particulate matter discharged into the atmosphere from any source shall not exceed the rates provided in Table 405(a) of this Rule. Emissions shall be averaged over one complete cycle of operation or 1 hour, whichever is the lesser time period. This rule is a potential ARAR.
- Regulation XIII, Rule 1303, Best Available Control Technology – Any new or modified source of air contaminant that results in an emission increase of any nonattainment air contaminant, ozone-depleting compounds, or ammonia shall apply the best available control technology (BACT) using the published SCAQMD BACT Guidelines. The VOCs identified at Omega OU2 are precursors to ozone. This rule is a potential ARAR.
- Regulation XIV, Rule 1401, New Source of Toxic Air Contaminants – The rule specifies limits for maximum individual cancer risks (MICR), cancer burden, and noncancer acute and chronic health HI from new or existing sources that emit toxic air contaminants. Sources constructed with Best Available Control Technology for Toxics (T-BACT) should not exceed a cumulative carcinogenic increase greater than 10 in 1 million ( $1.0\text{E-}05$ ) at any receptor location or one in a million ( $1.0\text{E-}06$ ) for sources constructed without T-BACT. Additionally, the cumulative increase for the chronic HI should not exceed 1.0 at any receptor location for any target organ system due to total emissions from the source. This rule is a potential ARAR.

#### 2.3.3.4 To-Be-Considered Criteria

The TBC category consists of advisories, criteria, or guidance that were developed by EPA, other federal agencies, or states that may be useful in developing CERCLA remedies. The following paragraphs describe TBCs identified as potentially useful to the development and evaluation of remedial alternatives for Omega OU2. The TBCs are summarized in Table 2-2A.

##### California Notification Levels (NLs)

NLs are health-based advisory levels established by CDPH for contaminants that lack primary MCLs. NLs are advisory levels, not enforceable standards. An NL is the concentration of a contaminant in drinking water that is considered not to pose a significant health risk to people ingesting that water on a daily basis. It is calculated using standard risk assessment methods for noncancer and cancer endpoints and typical exposure assumptions, including a 2-liter-per-day ingestion rate, a 70-kilogram adult body weight, and a 70-year lifetime.

**1,4-Dioxane.** For 1,4-dioxane, a chemical considered a possible carcinogen and a COC at Omega OU2, the CDPH NL is  $3\text{ }\mu\text{g/L}$ . This concentration is a level considered to pose a “de minimis” risk (i.e., a theoretical lifetime increase in risk of up to one excess case of cancer in a population of 1,000,000 people – the  $1\times 10^{-6}$  risk level).

**Total and Hexavalent Chromium.** The California MCL for total chromium is 50 µg/L, and hexavalent chromium in drinking water is currently regulated under the total chromium MCL. For this FS, the screening level used for hexavalent chromium is 11 µg/L, which is the California Toxics Rule requirement for Aquatic Life Protection. In addition, the California Office of Environmental Health Hazard Assessment is currently developing a Public Health Goal (PHG) for hexavalent chromium in drinking water, and the eventual PHG will likely be below the 11 µg/L screening level used in this FS. Consequently, for alternatives where drinking water is the end use, the target level for treatment of hexavalent chromium will likely be lower than the screening level.

#### **California Well Standards Bulletin 74-81; 74-90**

Substantive standards for the construction of wells have been published by the State of California. California Well Standards Bulletin 74-81 includes municipal and injection well standards. California Well Standards Bulletin 74-90 amends Bulletin 74-81 and includes monitoring well standards. While these standards have not been promulgated and, therefore, are not ARARs, the extraction wells for municipal reuse and injection wells at Omega OU2 will comply with substantive water well construction standards of Bulletin 74-81 and amendments contained in Bulletin 74-90. These standards include annular sealing material and construction, well casing specification, and disinfection procedures. However, extraction and injection well siting requirements are inappropriate for Omega OU2 because the effectiveness of the remedy is dependent upon well locations. These California well standards are TBCs for Omega OU2.

#### **Policy Memo 97-005: Policy Guidance for Use of Extremely Impaired Sources**

This policy does not set numerical discharge limits, but establishes a process, including permitting, that must be followed before using an extremely impaired water source as a drinking water supply. This is a policy adopted by the CDPH, and is not a promulgated requirement. Therefore, it is not an ARAR for onsite actions. However, CDPH would enforce this policy for any actions taken offsite (i.e., for the delivery of any treated OU2 water for use in a public water supply system).

#### **Fish and Game Commission Wetlands Policy (adopted 1987) included in Fish and Game Code Addenda**

This policy seeks to provide for the protection, preservation, restoration, enhancement, and expansion of wetland habitat in California. Further, it opposes any development or conversion of wetland that would result in a reduction of wetland acreage or habitat value. It adopts the U.S. Fish and Wildlife Service (USFWS) definition of a wetland, which uses hydric soils, saturation or inundation, and vegetation criteria, and requires the presence of at least one of these criteria (rather than all three) to classify an area as a wetland. This policy is not a regulatory program and should be included as a TBC.

## **2.4 General Response Actions**

As defined in EPA guidance (EPA, 1988), general response actions are medium-specific actions likely to satisfy the RAOs. The GRAs developed for groundwater at OU2 are summarized below. Remedial technologies associated with certain GRAs are also listed as follows as subcategories of the GRAs, as appropriate:

- No Further Action
- Institutional Controls
- Monitoring
- Containment
  - Groundwater Extraction
  - Physical Barriers
  - Surface Water Controls
- Ex situ Treatment Cleanup Actions
  - Extracted Groundwater Treatment
  - Disposal of Treated or Untreated Waste Media (Wastewater and Residuals)
  - Treated Water Discharge or End Use Process Options
- In situ Treatment Cleanup Actions
  - Natural Attenuation
  - Chemical Processes
  - Biological Processes
  - Physical Processes

Although source removal and/or source control remedial technologies are often included as part of containment GRAs, for purposes of this FS, these are being addressed by current and planned source removal and/or source control measures at OU1, one of the main sources of contamination for the OU2 plume under EPA oversight, and at approximately 20 other source areas within the OU2 plume that are under state oversight. This OU2 FS does not include any additional source reduction or source control remedial actions.

Except for the No Action Alternative, each general response action can be implemented using one or more remedial technologies. Remedial technologies are defined as the general categories of remedies that may be applicable to a given GRA. For example, ex situ groundwater treatment is one of the general remedial technologies applicable to the general response action of ex situ treatment cleanup actions. Process options are specific subcategories of remedies that can be integrated into each remedial technology to complete the remedy. Process options are used to implement each remedial technology. For example, the remedial technology of ex situ groundwater treatment could be implemented using one of several types of process options (such as air stripping or ion exchange).

## **2.5 Identification and Screening of Technology Types and Process Options**

General response actions are described in more detail below, and associated remedial technology types and technology process options deemed to be potentially applicable for implementing the GRAs are described, identified, and screened in this section for possible use in remedial alternatives developed in Section 3 of this FS.

Screening of technologies is based on effectiveness (primarily), implementability, and relative cost.

**Effectiveness** of remedial technologies and specific process options is evaluated by considering the following factors:

- Potential effectiveness of a remedial technology or process option to achieve the goals identified in the RAOs
- Potential impacts to human health and the environment during the construction, implementation, and operational phases
- Reliability and success of the process with respect to the types of contamination and site conditions that will be encountered

**Implementability** is evaluated by considering factors such as the ability to obtain necessary permits (if any) and the availability of the equipment and workers to implement the technology. Implementability also considers the availability and capacity of treatment, storage, and disposal services.

**Cost** plays a limited role in the screening of process options. Relative overall cost comparison, including capital, operating, and maintenance costs, is used rather than detailed quantitative estimate comparison. The cost for each process option is evaluated based on engineering judgment relative to the other process options.

When multiple process options are considered effective, implementable, and cost-effective, a representative process option will be chosen and used in the subsequent development and analysis of remedial alternatives. In such cases, a ROD or other decision document is often written to defer the selection of a process option to the remedial design phase.

### 2.5.1 No-Action Alternative

Evaluation of a “No-Action” Alternative (or a no further action alternative if remedial actions have already been implemented) is required under the NCP (40 CFR 300.430). For this GRA, it is assumed that no remedial action would be performed. For the purposes of this FS, it has been assumed that the continued operation and maintenance of existing non-CERCLA remedial facilities (under state oversight) represents a common baseline activity within the OU2 area. The FS also assumes that continued operation of the OU1 interim containment remedy for groundwater is part of the baseline conditions.

Some degree of natural attenuation is likely already occurring at OU2 and will likely continue to occur under the No Action Alternative due to natural and uncontrolled processes. However, for purposes of this FS and its containment focus, natural attenuation will not be part of any identified remedial alternative.

### 2.5.2 Institutional Controls (ICs)

ICs are non-engineering controls that federal, state and local governments or private parties can use to prevent or limit potential exposure to hazardous substances, pollutants or contaminants, to ensure the effectiveness of remedial actions. Groundwater in and in the vicinity of OU2 is an important source of drinking water. The groundwater contamination in OU2 potentially limits the ability of numerous water rights holders to fully exercise their water rights, and it also could create a significant challenge for certain rights holders to

operate their production wells in a manner that is compatible with the groundwater contamination containment goals of the interim OU2 remedial action.

All of the remedial alternatives being evaluated would be subject to the existing controls on groundwater extraction and use already in effect in the Central Basin. One such control is the judgment by the Superior Court of California, County of Los Angeles (Superior Court Case No. 786,656) (“adjudication”), which established rights to extract groundwater in the Central Basin, as well as a court-appointed Watermaster with authority to administer the adjudication, including monitoring such rights and performing other functions.

In addition, entities that administer a public drinking water system are regulated by the CDPH. In general, production wells and associated water treatment and delivery facilities that supply drinking water to the public are subject to the approval by, and water quality reporting to, the CDPH. CDPH’s Policy 97-005 (Policy Guidance for Use of Extremely Impaired Sources) establishes a process to be followed before an extremely impaired water source can be used as a drinking water supply.

Further, a permit from Los Angeles County Department of Health Services (LACDHS) is required prior to installing any well in the OU2 area. The permit covers well construction specifications and location.

These well permit requirements, drinking water regulatory controls, and the Watermaster’s authority to regulate and allocate water resources, ensure a degree of centralized control over the extraction and use of OU2 area groundwater. However, these existing controls may not be adequate to ensure that water rights holders operate their production wells in a manner that is compatible with the groundwater contamination containment goals of the interim remedial action. Consequently, ICs may be necessary to ensure that the selected remedy is effective.

The primary ICs that were identified and considered for the interim OU2 remedial action include coordination with State and local agencies with jurisdiction over well drilling and groundwater use within the Central Basin, and notifications to holders of rights to extract groundwater. The information exchange provided by these ICs would protect public health by reducing the possibility that production wells in the vicinity of OU2 could become contaminated, and preventing operation of the wells from interfering with the plume containment goals of the interim OU2 remedy. These ICs have varying degrees of effectiveness, but are relatively easy and low in cost to implement.

One IC is the annual preparation and distribution of a notification to be provided to all water rights holders in the Central Basin, which would explain (1) the goals of the selected interim OU2 groundwater, the status of the remedy’s implementation, and the nature and extent of OU2 groundwater contamination; and (2) any related State or local restrictions and prohibitions on well-drilling and groundwater use without necessary approvals and permits.

Another IC is periodic (e.g., annual) meetings among EPA and State and local entities with jurisdiction over well drilling and groundwater use within the Central Basin, including the Watermaster, the County of Los Angeles, and the Cities of Whittier, Santa Fe Springs and Norwalk. The purpose of the meetings would be to periodically exchange all available information relevant to whether operation of any production well(s) within OU2 or its

vicinity is compatible with the groundwater contamination containment goals of the interim remedial action. Such information would include the status of OU2 contamination and the implementation of the selected interim OU2 groundwater remedy pursuant to the OU2 ROD. In addition, such information would encompass any permit(s) for well installation that had been applied for or granted in the OU2 area or vicinity and the compatibility of such permit(s) with the RAOs of the interim remedy selected in the OU2 ROD.

These meetings would be supplemented by an annual review of available documentation maintained by the State and local entities to determine if water supply wells have been installed, or a purveyor or other water rights holder had increased groundwater production or production capacity within OU2 or its vicinity.

If any information exchanged pursuant to the meeting or obtained through the documentation review suggested a possible incompatibility between the operation of production wells and the groundwater contamination containment goals of the interim OU2 remedial action, prompt notification to EPA would be provided, if not previously provided. Thereafter, EPA would take such actions it determines are necessary or appropriate to assure that such permit or authorization does not create a risk to human health or the environment, or impair or delay any response action for Omega OU2.

Limitations on the installation of new water production wells and water use in areas within or in the vicinity of the OU2 plume is another IC that was initially considered for the remedial alternatives. Such an IC would prevent potential exposure to chemicals of concern by limiting or preventing the installation of new production wells whose operation could capture or otherwise impact the flow of the OU2 plume. This could mean restricting well installation in areas within or in the vicinity of the OU2 plume, or restricting the screened intervals of such wells, requiring sanitary seals, etc. The limitations could also include restrictions on increased pumping from existing wells within or in the vicinity of the plume. These restrictions could be put in place through an agreement with the California Department of Water Resources, (DWR), CDPH, LACDHS, the Water Replenishment District of Southern California (WRD), and/or holders of water rights in the Central Basin.

Although this type of IC generally can be relatively effective, it likely would be difficult to implement for several reasons. Alternative sources of potable water may not be readily available due to long-term drought conditions in the southwestern region of the United States. The cost of replacement water could be very high. Furthermore, this type of IC would need to take into account the adjudication of water rights discussed above. In addition, its implementability would depend upon the agreement of numerous parties. Consequently, this IC was screened out from further consideration in this FS.

With the exception of the IC addressing limitations on production wells, the ICs discussed previously are a part of the remedial alternatives developed in Section 3 of this FS, except for the No Action Alternative, which features no ICs.

### 2.5.3 Monitoring

Monitoring of groundwater at OU2, physical conditions in the OU2 area, performance of remedial systems, and industrial and development activities that could potentially impact the OU2 remedy will be a necessary part of all of the remedial alternatives developed for

OU2. The monitoring will require the coordination and data sharing between EPA and state and local agencies.

Long-term groundwater monitoring is an important component of a containment alternative. Additionally, groundwater monitoring can provide data to help locate and design new extraction wells, if needed, and to verify modeling parameters. If treated groundwater is used for potable consumption, it is expected that CDPH will require that design of the system follow the 97-005 policy (because COC concentrations at OU2 exceed MCLs by more than a factor of ten and because of other considerations listed in the policy), which requires upgradient or early warning monitoring.

Monitoring at OU2 will include the following components:

- Groundwater monitoring of new and existing OU2 wells
- Groundwater monitoring data, obtained from state agencies, for other facilities at OU2 that are under state oversight
- Information obtained from state and local agencies regarding monitoring of physical conditions in the OU2 area, including rainfall, production pumping, and artificial groundwater recharge

Monitoring will be conducted quarterly to annually, depending on the objective of the specific monitoring well and the time after remedy implementation. A network of monitoring wells located in OU2, both existing and new (to be installed as part of the OU2 remedy), will be required to meet the monitoring requirements. The submittal of regular monitoring reports will also be required. The monitoring program will include analysis for COCs. A detailed long-term monitoring program associated with the selected alternative will eventually be developed as part of the remedial design.

Monitoring groundwater levels and groundwater quality will allow for evaluation of contaminant plume migration and the effectiveness of the selected remedial actions. The specific monitoring objectives that will be used to develop a groundwater monitoring network to support the selected remedy include the following:

- Provide an up-to-date interpretation of the nature and extent of contamination at OU2, as well as document its changes over time
- Identify and delineate target zones for groundwater remediation
- Provide updated hydrogeologic data for groundwater modeling needed to evaluate the effectiveness and performance of the remedy
- Expand the coverage of the monitoring well network as required
- Provide additional data to support remedial design, if necessary

Overall, monitoring has relatively high effectiveness, high implementability, and moderate costs for implementation. Monitoring will be part of the remedial alternatives developed in Section 3 of the FS.

## 2.5.4 Containment

These response actions reduce the mobility of chemicals, eliminate exposure pathways, and prevent the migration of contamination in groundwater into yet unimpacted aquifer zones. These actions are outlined in the following subsections.

### 2.5.4.1 Groundwater Extraction – Containment Actions

These response actions include pumping of groundwater to limit the spreading of the existing contaminant plume outside OU2. The extraction of groundwater at selected (optimized) locations can provide hydraulic control of groundwater migrating laterally downgradient or vertically into deeper aquifer units. The containment could be complete (i.e., contain all groundwater with Omega contaminant concentrations above screening levels) or partial (e.g., containment of the high concentration areas only).

Groundwater extraction can be relatively moderate to high in effectiveness and can be readily implemented, but can be relatively high in cost due to potentially large volumes of water requiring conveyance, treatment, and discharge.

This remedial technology will be retained for possible use in development of remedial alternatives.

### 2.5.4.2 Physical Barriers

Physical barriers involve physical structures designed to prevent or minimize movement of groundwater past the structures. These include barriers such as slurry walls, grout curtains, or sheet piling. In general, these barriers can be installed practicably only to depths of less than 100 feet. Groundwater mounding behind these barriers can divert groundwater to other uncontaminated areas; barriers may have to be supplemented by other actions.

Physical barriers can be relatively effective; however, they would be very impractical to design and install over the large OU2 groundwater plume that is about 4.5 miles long x 0.5 to 1.0 mile wide and is present in the depth interval between about 100 and 200 feet bgs. The costs for installing physical barriers would be very high. Because the OU2 area is highly developed, with industrial and commercial buildings and busy streets, the physical construction of the barriers would be very difficult. Implementing this technology would require extensive and complex permitting, regulatory agency involvement, and stakeholder negotiations.

Physical barriers will not be retained as a remedial technology for developing remedial alternatives.

## 2.5.5 Ex Situ Treatment Actions

These response actions provide for treatment of extracted groundwater prior to disposal. Because of the varying nature of contamination over OU2 and numerous possible end uses of treated water, the treatment options include a range of technologies. In addition, the use of a single large centralized treatment plant or multiple smaller groundwater extraction and treatment systems that operate throughout OU2 will be considered.

The existing treatment systems under EPA oversight at OU1 and existing and planned treatment systems under state oversight at source areas within OU2 will be assessed to

determine if and how they can be integrated into or accounted for in the overall OU2 cleanup actions. Specifically, they will need to be assessed with respect to how reliable and effective they are and how compatible they are with overall OU2 objectives; and if they can be adjusted to achieve modified objectives consistent with overall OU2 objectives, if necessary.

Treatment technologies for contaminated groundwater would be designed to reduce the toxicity or mobility of the COCs. Treatment technologies considered include chemical, physical, and biological treatment for the COCs. The COCs identified in the RI are summarized in Table 2-1, along with their maximum detected concentrations

This table is used to identify a range of treatment technologies, discussed in this section, which are potentially capable of treating the identified COCs. The estimated treatment plant influent concentrations based on extraction locations and extraction volumes will differ from the Table 2-1 data because they are specific to remedial alternatives that will be developed in Section 3 of this FS. In Section 3, representative treatment technologies and process options retained through the screening process will be considered for use in the development of remedial alternatives.

#### **2.5.5.1 Groundwater Treatment Technologies**

Groundwater treatment technologies are used to restore the quality of the extracted groundwater to make it suitable for whatever intended end use or disposition is chosen. A description of potentially applicable treatment technologies is discussed in this subsection. The listed technologies are commercially proven and have been used in full-scale contaminated groundwater treatment applications. There are a number of technologies that have been studied or are currently being studied that have potential treatment applications involving the OU2 COCs but have not been commercially proven. These have been specifically excluded in the discussion below.

##### **Air Stripping**

Air stripping technology is potentially effective for the removal of the following contaminants identified in Table 2-1:

- TCE
- PCE
- 1,1-DCE
- 1,2-DCE
- Chloroform
- Carbon tetrachloride
- 1,1,1-TCA
- Freon 11
- Freon 12
- Gasoline fuel constituents (benzene, toluene, ethylbenzene, and toluene)

Air stripping is a commonly used process for treating groundwater contaminated with VOCs. In the air stripping process, water is introduced into the top of a vertical vessel and flows downward countercurrent to an upward flowing air stream. In the air stripper, the contaminants are transferred into the air phase. The air phase is then treated in various

ways (see following discussion) to capture or destroy the contaminants such that they are not released to the atmosphere. Air stripping can be accomplished in a number of ways using different types of equipment including the following:

- Packed-tower aeration
- Low-profile aeration
- Bubble diffusion
- Aspiration or centrifugal stripping

Usually, the air stream containing the VOCs must be treated to capture the VOCs before the air is released to the atmosphere. Numerous treatment technologies exist for treating the air stripper off-gas. These are discussed in the Ancillary Technologies subsection. The most often used off-gas treatment technologies are vapor phase granular activated carbon (VGAC), catalytic, and regenerative thermal oxidation.

Air stripping is a common remedial technology that is very effective and easily implementable; however, costs can be high to moderate depending upon the quantity and nature of the contaminants to be removed.

This remedial technology will be retained for possible use in development of remedial alternatives.

### **Advanced Oxidation Processes**

Advanced Oxidation Processes (AOPs) are a potentially effective technology for the removal of 1,4-dioxane and many VOCs. This treatment technology typically employs ultraviolet (UV) light and a chemical oxidant. In the process, hydroxyl radicals are formed from UV light or ozone ( $O_3$ ), in combination with the injection of an oxidant (Ox) such as hydrogen peroxide, to destroy contaminants in groundwater such as 1,4-dioxane and VOCs. In a UV/Ox treatment system, the oxidant is injected into the contaminated water, which then passes through a tank or vessels containing numerous UV lamps. The UV light and oxidant form hydroxyl radicals that react with 1,4-dioxane and VOCs to degrade them. Similarly, in an  $O_3$ /Ox treatment system, ozone is generated and injected into the contaminated water along with an oxidant to form hydroxyl radicals that react with specific contaminants to destroy or degrade them. AOP systems are available as packaged systems in a wide range of sizes and capacities.

AOP technology can remove many VOCs, as well as 1,4-dioxane and n-nitrosodimethylamine (NDMA). However, certain VOCs, such as alkanes (e.g., 1,1,1-TCA) are not readily destroyed by AOP. In addition, certain by-products can sometimes be formed from VOC degradation. Consequently, a more complex treatment system including an air stripper or liquid-phase granular activated carbon (LGAC), or both, is often used in conjunction with an AOP system to remove these residual contaminants.

It should be noted that, as a consequence of the use of AOP technology to remove 1,4-dioxane, excess hydrogen peroxide could be found in the treated water. AOP effluents can contain a few parts per million (ppm) of residual hydrogen peroxide. Acceptable hydrogen peroxide concentrations depend on the end use. For potable water, residual hydrogen peroxide is not acceptable and would be removed, for example, by simple chlorination. Catalytic carbon reactors can be provided after the AOP system to remove

residual peroxide prior to discharge of the treated water depending upon the end use of the water.

AOPs have relatively moderate implementability. Often, bench or pilot testing may be required to establish design parameters. AOP processes are relatively higher in cost compared to air stripping or LGAC with regard to VOC removal alone, but the process is needed if 1,4-dioxane removal is required.

This remedial technology will be retained for possible use in development of remedial alternatives.

### **Biological Treatment**

Biological treatment is potentially effective for the removal of perchlorate, hexavalent chromium, selenium, and many VOCs. Biological treatment consists of adding nutrients in a controlled environment to sustain microbes that are capable of anaerobic, anoxic, or aerobic degradation of contaminants. Although the biological treatment method for contaminants such as perchlorate is relatively new, biologically active filters have been used in drinking water treatment for decades to help remove particles and biodegradable organic matter.

Biological treatment can be accomplished in fixed bed, fixed film, or in fluidized bed bioreactors (FBRs). It would operate by augmenting influent contaminated groundwater with a carbon substrate (ethanol, acetate, or acetic acid [vinegar]) and trace concentrations of nutrients (phosphoric acid) to promote biological growth. After the carbon substrate and nutrients are added, the contaminated groundwater would be introduced into the fluidized bed-type bioreactor that contains GAC covered with a coating of bacteria adapted to degrade the specific contaminant of concern. For perchlorate removal, an FBR would operate in an anoxic mode, meaning it is not aerated and uses nitrate and the contaminant for cellular respiration instead of oxygen. A VGAC drum is often necessary to capture trace VOC emissions. The bioreactor produces a waste biomass that requires dewatering, typically in a plate-and-frame-type filter press, and subsequent sludge disposal. After the bioreactor, the groundwater would be filtered to remove the trace levels of biomass in the water prior to the end use of the treated water. The media filter used for filtration would also require backwashing. The backwash wastewater would be captured in a backwash storage tank and settle sludge would be filtered using a plate and frame type filter press.

The disadvantages of biological processes are that it may produce unwanted VOCs and can be susceptible to process upsets due to significant changes in contaminant concentrations or other water quality parameters. Biological processes can require significant time for startup to allow for biological acclimation and stabilization.

Biological processes are proven, effective, and readily implementable. The relative cost of biological processes is moderate to high compared to air stripping or LGAC in terms of VOC removal. The relative cost of biological processes compared to ion exchange for removal of perchlorate, for example, is application specific, but tends to be higher than ion exchange if nitrate levels in groundwater are low.

This remedial technology will be retained for possible use in development of remedial alternatives.

### **Ferrous Iron Reduction with Filtration**

Ferrous iron reduction with filtration is potentially applicable for the removal of selenium and hexavalent chrome. Ferrous iron reduction decreases total chromium concentrations by chemically reducing hexavalent chromium (Cr+6) to trivalent chromium (Cr+3) and coprecipitating trivalent chromium with ferric iron. The ferric iron and trivalent chromium coprecipitate is flocculated and removed using a conventional clarifier and media filter polishing. A sludge management system for dewatering the sludge for offsite disposal is required.

The key components of a ferrous iron reduction and filtration system include a series of reactors for ferrous iron reduction of hexavalent chromium to trivalent chromium. The first reactor is an inline vessel/pipeline reactor; the second reactor is a mixed tank reactor. These reactors are followed by aerated and stirred tank reactors for oxidation of residual ferrous iron to ferric iron. A microfilter or multimedia filtration system that is coupled with a backwash system removes ferric iron and trivalent chromium solids. A batch-thickening and dewatering system is used to treat the sludge prior to offsite disposal.

This process is very effective and readily implementable, but is more complicated than ion exchange (see following discussion). The relative cost of this technology compared to ion exchange for hexavalent chrome reduction can be higher or lower and is application specific.

Selenium has also been effectively removed from water using an iron co-precipitation process.

This remedial technology will be retained for possible use in development of remedial alternatives.

### **Liquid Phase Activated Granular Activated Carbon Adsorption**

Adsorption technology is potentially applicable for the removal of a wide range of contaminants including TCE; PCE; 1,1-DCE; 1,2-DCE; carbon tetrachloride; 1,1,1-TCA; and gasoline fuel constituents (BETX constituents, including benzene, ethylbenzene, toluene, and xylene). Chloroform, Freon 11, and Freon 12, although not as readily amenable to adsorption, can also be effectively removed depending upon the concentrations in contaminated groundwater.

Adsorption is the process in which constituents adsorb (i.e., become attached) to the internal surface of activated carbon particles. The activity level of adsorption is based on the concentration of substance in the water, as well as the temperature and polarity of the substance. A polar substance (a substance that is soluble in water) cannot be removed or is poorly removed by activated carbon, whereas a nonpolar substance can be removed completely by activated carbon.

In a typical process, water is pumped through a vessel that contains activated carbon. Over time, the activated carbon becomes saturated with contaminants. However, each species is adsorbed onto the activated carbon to different degrees depending upon its characteristics. Some contaminants will be readily adsorbed onto the carbon whereas others are less adsorbable and tend to “break through” the carbon bed much sooner than others.

A typical lead-lag configuration is used in which the first bed is allowed to become saturated with respect to a chosen contaminant while a second bed is allowed to capture any “leakage.” When the first LGAC bed is saturated, the process is temporarily stopped; the lag bed is placed into the first position; and a new fresh bed of carbon is provided for the lag position. This approach maximizes carbon use efficiency. The LGAC process creates spent carbon that must be either regenerated offsite for reuse or disposed offsite as a solid waste.

This technology is very effective and relatively easy to implement. With regard to cost, LGAC tends to be relatively less expensive than air stripping when treating water with lower VOC concentrations and tends to be relatively more expensive than air stripping when treating water with higher VOC concentrations.

This remedial technology will be retained for possible use in development of remedial alternatives.

### **Biological Liquid Phase Granular Activated Carbon Adsorption**

In this process, the activated carbon serves as a substrate media for the formation of a biological treatment film that can effectively remove organics in specialty applications for which conventional LGAC is not adequate. An example of this is the treatment of organic by-products formed in an AOP. These AOP by-products such as alkanes are not effectively removed in LGAC; however, they are potentially amenable to biological treatment. The treatment system is composed of conventional LGAC carbon vessels. However, instead of periodically replacing the carbon, it is periodically backwashed and scoured to remove the biomass that is formed in the carbon bed. The frequency of backwashing is based on the pressure drop increase across the biological liquid phase granular activated carbon (Bio-LGAC) system as the biomass builds up in the carbon vessel. The backwash water is typically sent to storage tank to allow settling of the biomass, addition of polymers to further enhance liquid-solids separation, and dewatering of the settled biomass sludge in a plate and frame filter press. The filtrate and decanted water from the backwash storage tank is recycled back to the front end of the process.

The process is effective in removing certain AOP by-product organics that otherwise would be difficult to remove with conventional LGAC alone. This process is easily implementable and relatively moderate in cost because the process requires a more robust backwash water and biomass sludge dewatering system.

This remedial technology will be retained for possible use in development of remedial alternatives.

### **Ion Exchange**

Ion exchange is potentially applicable for the removal of selenium, perchlorate, and hexavalent chromium. Ion exchange decreases total contaminant concentrations by exchanging the contaminant for chloride using a bed of ion exchange resin.

The major components of an ion exchange system are ion exchange vessels and a backwash system. Backwashing is performed periodically to remove broken resin beads and trace suspended solids. The backwash system recovers the backwash water. The backwash water can either be disposed of offsite as a wet sludge, or it can be dewatered before offsite disposal.

Ion exchange processes have been used in homes, businesses, and industry for softening hard water for decades. In this process, the water is first filtered through bag filter units to remove any suspended particulates. Following filtration, the groundwater is treated in ion exchange vessels. Ion exchange typically involves the passage of the contaminated water over a chloride-based resin. The contaminant ions replace the chloride ions in the resin, thereby removing the contaminant from the water and trapping it on the resin. Similar to LGAC for VOC treatment, the ion exchange resin reaches a breakthrough condition and becomes saturated with contaminants.

Ion exchange systems can be provided with single-use resin in which the resin is replaced periodically when it has lost its contaminant loading capacity. The spent resin is typically regenerated offsite by resin suppliers for reuse.

Alternatively, ion exchange systems can have regenerable resin beds in which the resin is regenerated with a sodium chloride solution. However, a major disadvantage of the regenerable ion exchange process is that a waste brine stream is produced during regeneration of the ion exchange resin. About 5 to 10 percent of the water passing through the process is lost as part of the waste brine. This waste must be disposed into an industrial sewer brine line, or the processes must be enhanced to include a brine treatment process. This increases capital costs and adds to the complexity of the overall process.

In addition, the ion exchange process causes a modest increase in the TDS of the water and a significant increase in chlorides. This may be critical depending upon which end use option is used. Reclaim and reinjection end uses, for example, may require relatively low TDS and chloride limits.

Overall, ion exchange technology can be effective for nitrate and metals removal as well as perchlorate and hexavalent chrome removal and is relatively easy to implement. Cost of ion exchange relative to a biological treatment process, for example, can be higher or lower depending upon water quality characteristics. If nitrate levels are high, for example, then a biological process may be more cost-effective for perchlorate removal compared to an ion exchange process because high levels of nitrate in groundwater could consume prohibitively large amounts of ion exchange resin.

This remedial technology will be retained for possible use in development of remedial alternatives.

### **Membrane Separation Processes**

Nanofiltration (NF) and reverse osmosis (RO) are membrane separation processes typically used to remove a wide range of ionic species, and in particular, to remove TDS and other contaminants from water. NF and RO technologies have potential application for producing water that is suitable for a range of end uses such as potable water, reclaimed water, aquifer reinjection water, and infiltration basins by removing specific contaminants and reducing TDS levels in the treated water, if required.

NF and RO are very similar to each other but differ in the types of constituents they can remove, as well as their operating conditions. NF can effectively remove over 99 percent of all divalent ions and operates at relatively lower pressure than a corresponding RO system. TDS reductions of over 50 percent are easily achieved using this technology. In contrast, RO can effectively remove essentially all the TDS, regardless of what form the constituents are

in, but operates at a substantially higher pressure level. The RO process can produce a cleaner, higher quality product water stream compared to NF.

The key element of NF and RO systems is a semipermeable membrane designed to allow certain constituents to pass through, while blocking others. The elements that pass through include water, usually smaller molecules of dissolved solids, and most gases. The constituents that do not pass through the membrane are concentrated in a smaller waste stream. Approximately 75 percent of the inlet feedwater is recovered as a higher purity water stream, while about 25 percent of feedwater must be disposed of as a concentrated brine. The water recovery rates and recovered water purity can be increased by use of more RO stages in series or arrays.

Both NF and RO are potentially applicable for producing potable water as part of an overall potable water treatment system. In particular, the shallow groundwater in OU2 is high in sulfates and TDS. Those levels would have to be reduced if this water were to be used as reclaimed water (Title 22) or for potable water use.

Membrane processes are very effective and relatively easy to implement. Compared to other treatment processes such as air stripping or LGAC, however, membrane processes are relatively higher in both capital and operating costs.

This technology will be retained for possible use in development of remedial alternatives.

### **Ancillary Groundwater Treatment Technologies**

Additional processes may be required in conjunction with the previously described treatment processes to provide a complete treatment system. These are complementary technologies and are listed below:

- **Multimedia Filters:** Used for particulate removal; requires periodic backwashing
- **Catalytic Carbon Adsorbers:** Used for removal of trace residual peroxide that is used in AOP
- **Disinfection:** Used to disinfect treated water for potable water or reinjection end uses; typical disinfection processes include the addition of various disinfecting chemicals such as chlorine, ozone, chlorine dioxide, chloramine, peroxone (ozone/hydrogen peroxide) or treatment with UV irradiation with UV light, or combinations of these
- **VGAC:** Used in conjunction with air stripping to treat off-gas to comply with agency air quality discharge limits or requirements
- **Thermal Oxidation:** Often used in conjunction with air stripping for off-gas treatment, including the following variations of oxidation technologies:
  - Conventional thermal oxidizer (relatively high temperature)
  - Catalytic thermal oxidizer (relatively low operating temperature)
  - Open-flame thermal oxidizer (flares)
  - Recuperative thermal oxidizer (high thermal efficiency)
  - Regenerative thermal oxidizer (highest relative thermal efficiency)

- **Biological Filters:** Used to treat air stripping off-gas; has large footprint area requirements
- **Sludge Management Systems:** Systems used to treat sludge that may be produced from equipment backwashing operations, biological processes, or in other ways, typically including storage tanks, sludge pumps, plate and frame filter presses, and polymer addition systems
- **Chemical Injection Systems:** Systems used for water conditioning or reaction with specific constituents in water as part of an overall treatment system, typically including carboys or tanks to store the chemicals and metering pump systems for injecting the chemicals; typical chemicals include polymers to enhance particulate or solids removal or settling, oxidizing or reducing agents for a specific purpose such as removal of residual chlorine if needed, and acid and base chemicals for pH adjustment

These ancillary processes are effective and implementable. Relative costs can vary and are application specific.

These ancillary treatment processes will be retained for development of remedial alternatives because some may be required as part of an overall remedial treatment system.

#### 2.5.5.2 Disposal of Treated or Untreated Waste Media

The GRAs will require the disposal of treated or untreated waste media such as wastewater and other waste residuals. Disposal of treated or untreated waste media is not necessarily a treatment technology option, but rather an often necessary consideration or part of many remedial technologies and is discussed in this section accordingly.

Some wastes may be generated from the treatment processes. Typical treatment process wastes include wastewater brines from membrane processes (e.g., RO and NF), equipment cleaning wastewater and associated sludges, spent activated carbon, spent ion exchange resin, and others. Wastewater can be discharged to industrial sewers if properly treated, whereas spent activated carbon can be sent offsite for regeneration and potential reuse in other applications. Ion exchange resins can be regenerated offsite for potential reuse or transported to an offsite disposal facility certified to accept this waste, along with wastewater-derived sludges that may be generated.

Wastes can also be generated from other remedial activities, such as drill cuttings from installing wells and purged water from well sampling. All wastes generated during remediation would be transported to an offsite disposal facility certified to accept these wastes. Disposal of wastes in an engineered disposal cell onsite is not considered practical.

These process options are effective and implementable. The costs associated with certain options such as transportation to an offsite disposal facility certified to accept these wastes can be high, depending upon the quantities of waste requiring disposal.

These process options or considerations will be retained because they will be required in developing remedial alternatives.

### 2.5.5.3 Treated Water Discharge or End Use Process Options

The methods for discharge, end use, or disposal of treated groundwater include the following:

- Drinking water
- Reclaimed water
- ReInjection
- Aquifer infiltration via spreading basins
- Discharge to POTW sewer
- Storm drain

#### Water Rights

One of the key factors in the development of discharge or end use options is the issue of water rights in the Central Basin. The Central Basin is an adjudicated water basin with a court-appointed Watermaster, the DWR. WRD works with the DWR, Southern District Office, to track groundwater extractions and enforce water rights. In general, groundwater cannot be extracted in the Central Basin without water rights. Ways to obtain water rights include the following:

- Leasing or buying water rights from a water rights holder
- Developing an agreement with one or more water purveyors who have available water rights and is willing to accept treated water using such water rights
- Obtaining a Nonconsumptive Water Use (NWU) Permit from WRD, in which case the remedy-implementing entity without water rights would partner with a water rights holder to “borrow” their rights (This is done in name only, and does not affect allowed extractions of the water rights holder. The WRD typically assists and helps facilitate the NWU permit process for groundwater remediation projects. The NWU Permit is generally valid for up to 5 years at WRD’s discretion, at the end of which time the permit would need to be renewed.)

In addition to the water rights issue, the WRD collects a replenishment assessment fee for all extracted groundwater to fund replenishment of the groundwater. The replenishment assessment was \$153 per acre-foot (AF) in 2009 and has been increased to \$205 per AF for the 2010 to 2011 fiscal year; the fee will likely further increase over time. Groundwater cannot be extracted from WRD’s service area without paying the replenishment assessment, unless the party qualifies for and WRD grants a replenishment assessment exemption related to groundwater remediation. At its discretion, the WRD may grant an exemption from the replenishment assessment only if the following findings can be made:

1. The groundwater to be extracted is unusable, and it is not economical to blend it for use with other water, or
2. The proposed program involves extraction of usable water in the same quantity as what will be returned to the ground without any degradation in the quality of the water

Thus, remediation alternatives that use the extracted water in a beneficial manner are subject to the replenishment assessment. The duration of any replenishment assessment

exemption and/or NWU Permit is subject to the discretion of the WRD but typically requires renewal every 5 years.

In addition, it is possible that there can be multiple points of discharge or end uses of treated groundwater at OU2. For example, if RO treatment is used in conjunction with potable water (or other) end use, the residual brine will have to be discharged separately. Also, for multiple end uses, several groundwater extraction and treatment systems operating concurrently with individual discharges may be required. A single discharge option may not be practical for all groundwater extracted at OU2; therefore, a combination of the following discharge options and end uses is considered.

### **Drinking Water End Use**

Treated water would be distributed to local water purveyors for use as a potable water supply after suitable treatment. Initial discussions with the City of Santa Fe Springs indicate a general willingness to accept suitably treated water into its nearby potable supply system. This end use would require extensive monitoring. This remedial approach would be moderately difficult to implement due to the need to go through the CDPH 97-005 permit application process because the treated water would be considered to be coming from an impaired source. The advantage of this approach is that water would be reused in a productive manner.

Water rights would have to be obtained by leasing or buying water rights or negotiating an agreement with one or more purveyors that would be recipients of the potable water to use their water rights. The extracted water would be subject to a replenishment assessment. However, for purposes of this feasibility study, it is assumed that negotiations with the water purveyor receiving the potable water would result in the water recipient paying the replenishment assessment as they normally would.

The drinking water treatment process will generate a waste brine stream high in TDS which cannot be reused and will be discharge to a sewer. A NWU Permit and replenishment assessment exemption could be obtained, at WRD's discretion, for the volume of water extracted that ends up as non-reusable waste brine.

This end use option is retained for possible use in development of remedial alternatives.

### **Reclaimed Water End Use**

Treated water may be distributed to an existing CBMWD reclaimed water pipeline network in the area for reuse as irrigation or industrial water. In general, the water quality requirements for reclaimed water for industrial use purposes are the lowest compared to drinking water, reinjection, and spreading basin end uses. However, for reclaimed water use for irrigation purposes, the water quality requirements can be higher because irrigation runoff can flow into storm drains and effectively become a surface water discharge with more stringent discharge limits.

Implementation of this end use option may be moderately to highly difficult because treated water production will exceed demand for reclaimed water at different times of the year. Reclaimed water demand is seasonal and varies considerably throughout the year. The highest demand is in the summer season, and the lowest demand is in the winter season. This cyclical demand would negatively impact plume capture efficiency because extraction rates would have to be reduced significantly for prolonged periods of time. Use of reclaimed

water, therefore, may not be a viable stand-alone end use option. On the positive side, OU2 reclaimed water can possibly discharge into an existing reclaimed water pipeline in the area.

The Sanitation Districts of Los Angeles County (LACSD) currently provides reclaimed water to the CBMWD for distribution purposes. The LACSD can produce much more reclaimed water than can be utilized in the region. As such, plans are underway by agencies such as CBMWD to encourage reclaimed water use and to expand the reclaimed water distribution system. For this treated water end use option, the LACSD would have to reduce the amount of reclaimed water it supplies to CBMWD commensurately with the amount of water that would be provided from OU2. Discussions and negotiations with the LACSD would be required at the early stage of the RD phase to develop an arrangement such as this.

Water rights would have to be obtained by leasing, buying or negotiating use of water rights as discussed for the drinking water alternative. A replenishment assessment fee would be assessed because the water is being used beneficially.

The reclaimed water treatment process will generate a waste brine stream high in TDS and which cannot be reused and will be discharge to a sewer. A NWU Permit and replenishment assessment exemption could be obtained, at WRD's discretion, for the volume of water extracted that ends up as non-reusable waste brine.

This end use option will be retained for possible use in development of remedial alternatives.

### **Reinjection**

Reinjection of the treated groundwater into the aquifer would benefit regional water reuse efforts and sustainability of water resources in the Central Basin. If the entity implementing this remedial end use option does not have water rights, an NWU Permit would have to be applied for and obtained from the WRD. Under current water regulations, this end use option would qualify for a replenishment assessment exemption at WRD's discretion because treated water of the same quantity and quality would be put back into the groundwater.

This end use would also generate non-usable waste brine (about one-quarter of the total flow). Since this water is not reusable and has no beneficial use, this wastewater would qualify for a replenishment assessment exemption at WRD's discretion.

**Deep Aquifer Reinjection.** Within the OU2 area, reinjection would have to be into deep aquifer zones, generally below 200 feet bgs, in order to avoid causing hydraulic interference with the containment and to avoid mobilizing existing plumes in the shallow aquifer.

For reinjection into deep aquifer zones that are currently used for the production of drinking water, the extracted water would have to be treated to relatively strict discharge standards that are often more stringent than drinking water standards. There are prohibitions against degrading groundwater used for potable uses. Under the state's anti-degradation policy, water that may meet drinking water standards might require additional treatment prior to injection because one or more water quality parameters in the existing drinking water aquifer may be better than water that is treated to just meet drinking water standards. An example of this could be TDS concentrations for which the drinking water MCL is 500 mg/L

TDS. If the existing groundwater contains only 400 mg/L TDS, the injection water would have to be treated to reduce TDS levels to 400 mg/L or less prior to injection. Another example is if existing groundwater does not contain 1,4-dioxane, the injection water would have to be treated to below detection levels.

This option is highly effective in dealing with extracted and treated groundwater. This discharge option would be available year-round because the receiving aquifer would have sufficient capacity to accept the treated water. It would be moderately difficult to implement because extensive permitting and agency approvals would be required. This end use option will be retained for possible use in development of remedial alternatives.

**Shallow Aquifer Reinjection.** Reinjection into the shallow aquifer zones within 200 feet bgs would require a relatively complex system of extraction and injection wells. The injection wells are not appropriate for installation upgradient of OU2 due to low permeability soils in that area. Injection downgradient (generally south) of OU2 is also unfavorable because the induced flow may mobilize groundwater contamination at other sites, such as the Golden West Refinery (13116 Imperial Highway, Santa Fe Springs, California). Injection crossgradient (generally west and east) of OU2 may also mobilize groundwater contamination at sites outside OU2, including Ashland Chemical (10505 South Painter Avenue, Santa Fe Springs, California). Shallow reinjection crossgradient of OU2 could also interfere with existing source control measures at OU1 and future source control measures at the approximately 20 source areas within OU2.

On the other hand, the discharge requirements for shallow reinjection are less strict than those for deep reinjection because the shallow aquifer is not being used as a drinking water resource. The shallow aquifer has higher TDS and generally lower groundwater quality than the deep aquifer units. Shallow injection water would typically have to comply with waste discharge permit requirements from the RWQCB and would require meeting MCLs or NLs.

This discharge option would be available year-round because the receiving aquifer would have sufficient capacity to accept the treated water. Although this option would be relatively easy to implement physically, it would be very complex in terms of potential interference with other remedial efforts (such as source control systems within OU2 and at sites outside OU2). It would be difficult to implement because extensive permitting and agency approvals would be required, as well as negotiations with parties responsible for other potentially affected remedial systems.

This option is relatively moderate to high in cost compared to the other discharge or end use options because multiple injection wells would have to be installed around the plume and piping would be required from the treatment plant(s) to each injection well, which would increase the conveyance pipeline costs. Treatment cost would be relatively lower.

This end use option will not be retained as a separate option, but deferred to the RD. For example, shallow reinjection could be used for protection of production wells.

### **Discharge to Spreading Basins**

Treated water may be distributed into surface water features, such as to the San Gabriel River (unlined portions) and to the spreading basins along the San Gabriel and Rio Hondo Rivers that are currently used for infiltration and recharging of the aquifer. The spreading

basin area also includes unlined portions of the San Gabriel River. This option would not be available for approximately 1 month each year because the spreading basin and river channels undergo a shutdown period for maintenance. This discharge option will also be limited during the wet season when discharge to spreading basins or to unlined portions of the San Gabriel River would be curtailed or suspended during and after rainfall events. To compensate for these curtailed or suspended spreading basin discharge episodes, the extraction and treatment systems would have to be somewhat oversized such that desired annual average extraction rates could still be achieved.

Other than natural water flows from rainfall events and from upstream watershed areas, one of the major sources of water to the spreading basins is reclaimed water from the San Jose Creek Water Reclamation Plant (WRP), which is owned and operated by the LACSD. The LACSD is currently limited in the amount of municipal wastewater-derived reclamation water that can be used for infiltration in the spreading basins. This limitation is based on specific ratios of natural water to reclamation water that cannot be exceeded as specified by state water board mandates, as a means to maintain the water quality in the aquifer. One positive aspect of discharge to spreading basins is that the OU2 treated water is not viewed as a municipal source and would be considered “dilution water.” Accordingly, discharge of OU2 treated “dilution water” would allow the LACSD to send more reclamation water to the spreading basins, while still complying with established natural dilution water to reclamation water ratios. Overall, this would benefit regional water reuse efforts.

The spreading basin end use option is an effective means of reusing treated OU2 water. Due to seasonal limitations, the design capacity of the OU2 extraction and treatment system may have to be increased to allow operation at higher capacities when the spreading basins are available such that annual average extraction rates needed for contamination containment would be achieved.

Implementation will likely be moderate in relative difficulty. Implementation would require permitting and approvals from multiple cognizant agencies such as the Los Angeles County Department of Public Work, the California Department of Fish and Game, and the United States Army Corps of Engineers.

The relative cost of this option could be high depending upon the length of the pipeline system needed to convey treated water to suitable spreading basin locations and is application specific. The cost of this option could be considerably reduced if a suitable portion of the existing storm drain system could be used to convey treated water to unlined portions of San Gabriel River for infiltration.

Discharge of the treated groundwater into the aquifer would benefit regional water reuse efforts and sustainability of water resources in the Central Basin. If the entity implementing this remedial end use option does not have water rights, then an NWU Permit would have to be applied for and obtained from the WRD. Under current water regulations, this end use option would qualify for a replenishment assessment exemption at WRD’s discretion because treated water of the same quantity and quality is put back into the groundwater.

This end use would also generate non-usable waste brine (about one-quarter of the total flow). Since this water is not reusable and has no beneficial use, this wastewater would qualify for a replenishment assessment exemption at WRD's discretion.

This end use option is retained for possible use in development of remedial alternatives.

### **Discharge to POTWs**

Treated water may be discharged to a municipal sewer with no beneficial reuse. POTW discharge standards are the least stringent of all the discharge and end use options.

This discharge option is effective as a means of dealing with extracted and treated water. However, it would be difficult to implement from a POTW agency perspective. The cognizant POTW agency, the LACSD aims to conserve the agency's limited wastewater treatment capacity and has a general prohibition against accepting groundwater. The LACSD will accept groundwater on a case-by-case basis, only if demonstrated that it is technically impossible to treat and reuse the water or if it is too costly to implement treatment for alternative uses (such as treatment to National Pollutant Discharge Elimination System [NPDES] standards for discharge to storm drains or injection). Although physically easy to implement, this option would otherwise be difficult to implement because of water rights issues and because it is inconsistent with water conservation efforts in the drought stricken Southern California.

Since this water is not reusable and has no beneficial use, this wastewater would qualify for a replenishment assessment exemption at WRD's discretion.

Although discharging to POTWs would likely have the lowest relative costs for a treatment plant, the overall relative cost of this discharge option may be moderate compared to the other discharge or end use options. This is because recently, the LACSD has tripled its sewer connection fees. A discharge of 2,000 gpm, for example, would have sewer connection fees in excess of \$30,000,000.

As a discharge option, discharge to POTW will not be retained for use in alternatives development. However, it will be retained as a means of discharging smaller volumes of wastewater that may be generated in any or all of the remedial alternatives that may be developed in Section 3 of this FS.

### **Discharge to Storm Drains**

In this option, water would be treated to comply with NPDES discharge standards and would be discharged to nearby storm drains or storm channels. The discharge to the stormwater drain(s) may be limited by their capacity and may not be available during and following precipitation events, in which case discharge would have to be curtailed or suspended temporarily.

This option is a potentially effective means of dealing with extracted water. However, due to seasonal changes, the design capacity of the OU2 extraction and treatment system may have to be increased to allow operation at higher capacities when the storm drain system is available such that annual average extraction rates needed for contamination containment would be achieved. The efficiency of plume capture under this mode of operation would have to be assessed and confirmed in detail.

Although this option may be relatively easy to implement physically, it would otherwise be very difficult to implement because of water rights issues and because it is inconsistent with water conservation efforts in the drought stricken Southern California.

Treatment costs could be relatively high or low depending upon the distances to and capacity of existing storm drains and channels in the area. If existing storm drain capacity is too low, the capacity may have to be expanded, or the treated water would have to be conveyed longer distances to a location where storm drain capacity is adequate.

As a discharge option, discharge to storm drains will not be retained for use in alternatives development. However, it will be retained as a possible way to route treated water to unlined portions of the San Gabriel River for infiltration, as discussed above in the spreading basin end use option.

### **2.5.6 In Situ Treatment Actions**

In situ cleanup actions are typically used to restore the groundwater quality and for the contaminant mass reduction at source areas, but they can also be used as part of a containment remedy.

Examples include natural attenuation and chemical, biological, thermal, and physical treatment. These response actions involve the treatment of contamination in the groundwater at OU2 to prevent further migration of the contaminants. These actions consider a range of technologies and approaches including natural attenuation, in situ treatment, thermal desorption, and air sparging (AS) with soil vapor extraction (SVE).

In situ treatment technologies are focused on reducing the toxicity, mobility, and volume of contaminated groundwater from the source area. These treatment technologies produce less waste than ex situ treatment methods such as pump and treat systems.

Except for natural attenuation, all in situ treatment processes utilized as part of a containment remedy would be employed as a barrier to intercept the contaminant plume and prevent its further migration.

#### **2.5.6.1 Chemical Processes**

Chemical process options for in situ treatment include chemical oxidation, and chemical fixation. Chemical oxidation involves injection of a strong oxidizing agent such as hydrogen peroxide, sodium persulfate, or sodium permanganate, through a series of injection wells or trenches, or both. These oxidizing agents cause the rapid chemical degradation of some COCs.

A permeable reactive barrier (PRB) is an example of in situ chemical treatment. This technology is designed to prevent migration of contaminants along with groundwater. PRBs are trenches (walls or barriers) containing reactive media that are installed across the flow path of contaminated groundwater. The barrier allows water to pass through while the media removes the contaminants by precipitation, degradation, adsorption, or ion exchange. Chemically reactive media are used to treat specific COCs. Factors affecting PRB performance include the presence of fractured rock, heterogeneous lithology, deep aquifers, high aquifer hydraulic conductivity, and barrier plugging. PRB applications using oxidizing as well as reducing barriers in a linear configuration are not feasible at OU2 due to the huge

depth and width requirements of a barrier to intercept the contaminated groundwater plume.

The implementation of PRBs on the scale necessary for the containment of the OU2 plume is impractical, costly, and unfeasible. The cost of constructing PRBs that would need to extend 200 feet bgs and laterally across the width of OU2 would be very high. Because the OU2 area is highly developed, with industrial and commercial buildings and busy streets, the physical construction of the remedy would be very difficult. Implementing this technology would require extensive and complex permitting, regulatory agency involvement, and stakeholder negotiations. This option is not retained.

#### **2.5.6.2 Biological Processes**

In situ bioremediation (ISB) technologies involve addition of gases or nutrients, or both (and sometimes microorganisms), to the subsurface to stimulate biodegradation of contaminants by creating a favorable environment for the proliferation of microorganisms. Microbial degradation can be either aerobic or anaerobic. The success of a bioremediation process option depends on pH, temperature, redox conditions, and site hydrology, coupled with the conditions required for biodegradation of a given contaminant. For example, most chemicals degrade more rapidly and completely under aerobic conditions; however, contaminants such as PCE require anaerobic conditions to biodegrade. The delivery system for the nutrients would have to include multiple injection wells or deep trenches. The ISB barrier system would have to span across the width of OU2 and extend to approximately 200 feet bgs, which is technically not feasible. In addition, a linear barrier system would not fully contain the OU2 plume because vertical flow can transport contaminants into deeper layers throughout OU2. This process option would have limited effectiveness unless applied over the entire OU2 area.

The implementation of ISB on the scale necessary for the containment of the OU2 plume is impractical and unfeasible. This option is not retained.

#### **2.5.6.3 Physical Processes**

Physical process options for in situ treatment of contaminated groundwater include AS with SVE, fracturing, and thermal processes. AS removes VOCs and some semivolatile organic compounds (SVOCs) from groundwater by volatilization, and SVE then removes the contaminant vapors using vacuum blowers and vapor extraction wells. The contaminated vapor is collected at the surface and is treated or discharged to the atmosphere, or both. AS can be augmented with thermal processes to heat the water to enhance volatilization. Thermal processes for in situ treatment of contaminants in groundwater include electrical (resistive or radiofrequency) heating, steam injection, and hot air injection.

None of these technologies is technically feasible because the volume of contaminated water in the groundwater plume is enormous and contaminant concentrations are very low. Energy requirements would be prohibitively large.

Fracturing, using either hydraulic or pneumatic pressures, can create pathways in the soil matrix that increase the permeability of soils. Fracturing is not a stand-alone option, but is used with other in situ treatments such as chemical processes to increase efficiency of the overall process.

In general, each of these physical processes is typically applied to relatively small, concentrated areas or volumes of contamination. Application of these technologies to a large plume area and volume such as at OU2 is not practical. These physical in situ technologies are not retained for remedial alternative development.

### **2.5.7 Summary of Remedial Technology and Process Option Screening**

A summary of the screening and evaluation of remedial technologies and process options discussed above is presented in Table 2-3. Technologies retained from the screening process will be considered in the development of remedial alternatives in Section 3 of the FS.

TABLE 2-1

Summary of Contaminants of Concern

Feasibility Study Report for Omega Chemical Superfund Site in Whittier, California

Analyte	Range of Detected Concentrations	Screening Level	Number of Locations > Screening Level	Screening Level Source
<b>Volatile Organics (µg/L)</b>				
1,1,2,2-Tetrachloroethane	0.067 J to 5.6 J	1	1	CA Primary MCL
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	0.18 J to 2,400	1,200	4	CA/USEPA Primary MCL
1,1,2-Trichloroethane	0.081 J to 11	5	3	CA/USEPA Primary MCL
1,1-Dichloroethane	0.047 J to 200	5	9	CA Primary MCL
1,1-Dichloroethene	0.11 J to 2,700	6	33	CA Primary MCL
1,2-Dibromo-3-chloropropane	0.72 to 5.5	0.2	3	CA/USEPA Primary MCL
1,2-Dibromoethane	0.003 J to 3.4 J	0.05	2	CA/USEPA Primary MCL
1,2-Dichloroethane	0.05 J to 73 J	0.5	28	CA Primary MCL
Benzene	0.051 J to 19	1	11	CA Primary MCL
Carbon tetrachloride	0.048 J to 180	0.5	7	CA Primary MCL
Chloroform	0.046 J to 1,200	80	10	CA/USEPA Primary MCL
cis-1,2-Dichloroethene	0.064 J to 370 J	6	22	CA Primary MCL
cis-1,3-Dichloropropene	0.11 J to 3.8 J	0.5	2	CA Primary MCL for 1,3-dichloropropene
Methyl tert-butyl ether	0.05 J to 270	13	5	CA Primary MCL
Methylene chloride	0.069 to 400	5	8	CA/USEPA Primary MCL
Tetrachloroethene	0.052 J to 4,600	5	45	CA/USEPA Primary MCL
trans-1,3-Dichloropropene	0.42 J to 4.6 J	0.5	3	CA Primary MCL for 1,3-dichloropropene
Trichloroethene	0.095 J to 2,000	5	41	CA/USEPA Primary MCL
Trichlorofluoromethane (Freon 11)	0.047 J to 910	150	10	CA Primary MCL
Vinyl chloride	0.065 J to 4 J	0.5	4	CA Primary MCL
<b>Semi-Volatile Organics (µg/L)</b>				
bis(2-Ethylhexyl)phthalate	0.51 J to 80	4	18	CA Primary MCL
<b>Emergents (µg/L)</b>				
1,2,3-Trichloropropane	0.0024 J to 0.022	0.005	4	CA Department of Public Health State Notification Level
1,4-Dioxane (p-dioxane)	0.26 J to 210	3	29	CA Department of Public Health State Notification Level
Chromium VI	0.34 to 206	11	22	CA Toxics Rule for Aquatic Life Protection
N-Nitrosodimethylamine	0.0004 J to 0.03	0.01	4	CA Department of Public Health State Notification Level
Perchlorate	1 J to 10 J	6	9	CA Primary MCL
<b>Metals (µg/L)</b>				
Aluminum	13.1 to 2,260	50	23	USEPA Secondary MCL
Antimony	0.253 J to 25.5 J	6	8	CA/USEPA Primary MCL
Arsenic	0.44 J- to 30	10	5	USEPA Primary MCL
Chromium	0.36 J to 174	50	8	CA Primary MCL
Manganese	0.26 J to 2190	50	29	USEPA Secondary MCL
Mercury	0.02 J to 7.3	2	1	CA/USEPA Primary MCL
Nickel	0.26 J to 127	100	1	CA Primary MCL
Selenium	1.1 J to 88.4	50	3	CA/USEPA Primary MCL
Thallium	0.012 J to 13.8 J	2	13	CA/USEPA Primary MCL
<b>General Chemistry Parameters (mg/L)</b>				
Chloride	20 to 362	250	2	CA/USEPA Secondary MCL
Nitrate (as Nitrogen)	0.205 to 21	10	16	USEPA Primary MCL
Sulfate	9.2 to 1,350	250	46	CA Secondary MCL
Total Dissolved Solids	430 to 2,970	500	44	CA/USEPA Secondary MCL



TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
<b>CHEMICAL-SPECIFIC ARARs</b>			
Federal Primary Drinking Water Standards 40 CFR Part 141	Federal primary MCLs under the Safe Drinking Water Act protect the public from contaminants that may be found in drinking water. The MCLs are only applicable “at the tap” for drinking water provided to 25 or more people or water systems with 15 or more service connections. Because the groundwater underlying the Site has been identified as a potential source of drinking water, the requirements are relevant and appropriate to the aquifer underlying the Omega Chemical Superfund Site.	Groundwater	Relevant and appropriate
California Toxics Rule	Establishes water quality criteria for surface water and is typically implemented through NPDES permits.	Groundwater	Applicable
California Primary Drinking Water Standards Health and Safety Code (H&S Code) §4010 <i>et seq.</i> 22 California Code of Regulations (CCR) §64431 and 64444	California primary MCLs are established to protect public health from contaminants “at the tap” that may be found in drinking water sources. The California MCLs established for the primary contaminants are at least as stringent as the federal standard. The MCLs would be relevant and appropriate as a cleanup level for the Site.	Groundwater	Relevant and appropriate
Secondary Drinking Water Standards 22 CCR §64471	Secondary MCLs are applicable to public water system and establish aesthetic characteristics “at the tap” (that is, taste, odors, or appearance) of drinking water. None of the COCs at the Site include chemicals listed with secondary drinking water standards.	Groundwater	Applicable
California Water Code §13241, 13243, 13263(a), and 13360	Authorizes the state and regional water boards to establish in Water Quality Control Plans beneficial uses and numerical and narrative standards to protect both surface and groundwater quality. Authorizes regional water boards to issue permits for discharges to land, surface, or groundwater that could affect water quality, including NPDES permits, and take enforcement action to protect water quality.  The permits are administrative requirements and are not considered ARARs. The water quality standards, which are ARARs, are presented below.	Soil and groundwater	See specific requirements in text

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
Water Quality Control Plan for Los Angeles Region (adopted 06/13/94) California Water Code §13240 et seq.	Establishes beneficial uses of ground and surface waters; establishes water quality objectives, including narrative and numerical standards; establishes implementation plans to meet WQOs and protect beneficial uses, and incorporates statewide water quality control plans and policies. The WQOs for groundwater are based on the primary MCLs.  The Los Angeles plan designates the beneficial uses of groundwater in the Los Angeles coastal plain to be municipal and domestic, agricultural, industrial service, and industrial process supplies. Any activity that may affect water quality must not result in the water quality exceeding the WQOs. Discussion of the Basin Plan and discharge options are presented as action-specific ARARs.	Groundwater	Relevant and appropriate
State Water Resources Control Board (SWRCB) Resolution No. 92-49 Policy and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304 (amended 4/21/94) California Water Code §13307 23 CCR §2550.4	Establishes policies and procedures for oversight of investigations and cleanup and abatement activities resulting from discharges of waste that affect or threaten water quality.  Section III.G requires cleanup to attainment of either background water quality or the best water quality that is reasonable if background water quality cannot be restored. Alternative cleanup levels greater than chemical background concentration for the aquifer will be consistent with maximum benefit to the public, present, and anticipated future beneficial uses, and conform to water quality control plans and policies.	Soil and groundwater	Relevant and appropriate
<b>LOCATION-SPECIFIC ARARs</b>			
National Historic Preservation Act 16 U.S. Code (USC) §470 et seq. 36 Code of Federal Regulations (CFR) §60.4	The requirements establish a National Register and Advisory Council on Historic Preservation. Remedial activities that would affect a property on or eligible for the National Register are required to consult with the Advisory Council and the State Historic Preservation Officer. Surveys that may be required will result in the determination of adverse effects and the development of mitigation reports. Historic sites that would be affected by potential remedial activity at this location may be identified on or adjacent to the Site.	Soil and groundwater	To be determined

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
Fish and Game Code §3800	This section prohibits the take of nongame birds, except in accordance with regulations of the commission, or when related to mining operations with a mitigation plan approved by the department. This section further provides requirements concerning mitigation plans related to mining. This section is applicable and relevant to the extent that nongame birds or their eggs are located on or near the Site.		<u>To be determined</u>
Fish and Game Code §5650	The requirements prohibit the deposition into waters of the state, petroleum products, factory refuse, and any substance deleterious to fish, plants, or birds. This requirement does not apply to discharges or release authorized through waste discharge requirements issued by the RWQCB. This section is not an ARAR because none of the alternatives evaluate surface water releases.	Soil and groundwater	Not an ARAR
14 CCR §472	Regulation provides that nongame birds and mammals may be taken as follows: a) The following nongame birds and mammals may be taken except as provided in Chapter 6: English sparrow, starling, coyote, weasels, skunks, opossum, moles, and rodents (excludes tree and flying squirrels, and those listed as furbearers, endangered, or threatened species). b) Fallow, sambar, sika, and axis deer may be taken concurrently with the general deer season. c) Aoudad, mouflon, tahr, and feral goats may be taken all year. d) American crows may be taken only under provisions of Section 485 and by landowners or tenants, or person authorized by landowners or tenants, when American crows are committing or about to commit depredations upon ornamental shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. If required by federal regulations, landowners or tenants shall obtain a federal migratory bird depredation permit before taking any American crows or authorizing any other person to take them. This section is applicable if such species are found on or near the Site and may be affected by remediation efforts.		Applicable

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
Hazardous Waste Seismic Considerations 22 CCR §66264.18 22 CCR §66264.25	Portions of a new hazardous waste facility where treatment, storage, or disposal of hazardous waste will be conducted must not be located within 61 meters (200 feet) of a fault which has had displacement in Holocene time. The Site may be located within 61 meters (200 feet) of a fault that has had displacement in Holocene time.	Soil and groundwater	To be determined
<b>ACTION-SPECIFIC ARARS</b>			
Federal Clean Water Act National Pollutant Discharge Elimination System (NPDES) Clean Water Act (CWA) §402 et seq.	The NPDES requirements are applied to point and nonpoint discharge sources. Substantive requirements including the establishment of discharge limitations, monitoring requirements, and BMPs for surface water discharges. Applicable to the control of contaminants to stormwater runoff from a treatment plant construction site and groundwater treatment systems.	Evaluation of the Federal Clean Water Act provided below	Evaluation of the Federal Clean Water Act provided below
40 CFR §122.26	Nonpoint sources address using BMPs for control of contaminants to stormwater runoff from construction activities. SWRCB has established requirements for general construction activities, including clearing, grading, excavation reconstruction, and dredge and fill activities. Regulates pollutants in stormwater discharge from hazardous waste treatment plants, landfills, land application sites, and spent dumps.	Groundwater	To be determined
40 CFR §125.3	Point sources are primarily end-of-pipe discharge points such as treated effluent from a groundwater treatment plant. Discharges of treated effluent from a groundwater extraction system, monitoring well development and sampling, and treatment system maintenance are the primary sources. The RWQCB will designate effluent limitations and monitoring conditions for discharges to surface water including treated water conveyed to storm drains and ditches.  Technology-based treatment requirements represent the minimum level of control that must be imposed to meet the effluent limitations using best professional judgment and BAT economically achievable. For all toxic pollutants, the BAT is applied to the Site. The requirement is applicable to alternatives evaluating surface water discharge.	Groundwater	Applicable
40 CFR §403 et seq.	Alternatives that include groundwater disposal at an offsite wastewater treatment facility must meet pretreatment requirements. Effluent discharged to sanitary sewers and POTW are regulated by municipalities through the NPDES Program. Prevents pass-through, interference, violations of prohibitions, and violation of local limits. Applicable to brine discharge from treatment plant to the POTW.	Brine discharge from treatment plant	Applicable

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
Water Quality Control Plan	The RWQCB has developed and adopted the regional water quality control plan (Basin Plan) to protect waters of beneficial use fulfilling the legal requirements of the California Water Code. While the WQOs vary for the water bodies affected, the objectives may be applicable for discharges to surface water or land.	Evaluation of the Water Quality Control Plan provided below	Evaluation of the Water Quality Control Plan provided below
Water Quality Control Plan for Los Angeles Region (adopted 6/13/94) California Water Code §13240 et seq.	The Basin Plan presents numerical and narrative WQOs for maintaining a high quality of protection for the inland surface water and groundwater in the region. Groundwater underlying the Site has been identified by the Basin Plan as a potential drinking water aquifer. Groundwater and surface water WQOs are provided for contaminants including bacteria, chemicals, radioactivity, minerals, nitrogen, taste, and odor. The groundwater WQOs for the COCs at the Site are based on primary MCLs. Additional WQOs are provided for surface water. The requirement is relevant to alternatives evaluating treated groundwater reinjection to the aquifer and soil cleanup to protect groundwater quality, and applicable to alternatives evaluating discharge of treated groundwater to surface water.	Soil and groundwater	Relevant and applicable
Remediation of Pollution (State Board Resolution No. 68-16; State Board Resolution No. 92-49; California Code of Regulations, Title 23, Chapter 15, Article 5.)	The Basin Plan recognizes the cleanup goals based on the State's Antidegradation Policy as set forth in State Board Resolution No. 68-16. Under the Antidegradation Policy, whenever the existing quality of water is better than that needed to protect present and potential beneficial uses, such existing quality will be maintained. Accordingly, the Regional Board prescribes cleanup goals that are based upon background concentrations. For those cases wherein dischargers have demonstrated that cleanup goals based on background concentrations cannot be attained due to technological and economic limitations, State Board Resolution No. 92-49 sets forth policy for cleanup and abatement based on the protection of beneficial uses. Under this policy, the Regional Board can, on a case-by-case basis, set cleanup levels as close to background as technologically and economically feasible. Such levels must, at a minimum, consider all beneficial uses of the waters. Furthermore, cleanup levels must be established in a manner consistent with California Code of Regulations, Title 23, Chapter 15, Article 5; cannot result in water quality less than that prescribed in the Basin Plans and policies adopted by the state and regional boards; and must be consistent with maximum benefit to the people of the state.	Groundwater	Relevant and appropriate
Porter-Cologne Water Quality Control Act (California Water Code)	The following Porter-Cologne Water Quality Control Act and implementing regulations are reviewed for application to the Site.	Evaluation of the California Water Code provided below	Evaluation of the California Water Code provided below

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
California Water Code §13140 – 13147, 13172, 13260, 13263, 132267, 13304 27 CCR §20090	Actions taken by public agencies for cleanup of <i>nonhazardous</i> releases are exempt from 27 CCR Div. 2, Subdiv. 1 provided the contaminated materials removed from the immediate place of release shall be discharged according to 27 CCR Div. 2, Subdiv. 1, Chap. 3, Subchap. 2, Art. 2. Remedial actions intended to contain such wastes at the place of release shall implement applicable SWRCB-promulgated provisions of this division to the extent feasible.	Soil	To be determined
California Water Code §13140 – 13147, 13172, 13260, 13263, 132267, 13304 27 CCR Div. 2, Subdiv. 1, Chap. 3, Subchap. 2, Art. 2	Wastes classified as a threat to water quality (designated waste) may be discharged to a Class I hazardous waste or Class II designated waste management unit. Nonhazardous solid waste may be discharged to a Class I, II, or III waste management unit. Inert waste would not be required to be discharged into a SWRCB-classified waste management unit (27 CCR §20200 et seq.). The requirement is relevant because CERCLA waste may be generated as a result of investigation-derived waste and would be disposed at a EPA Region 9 approved facility, in accordance with CERCLA.	Soil	Applicable
California Water Code §13260 Report of Waste Discharge (ROWD)/Waste Discharge Requirements (WDR)	Any discharge of waste to land is required to be authorized through WDRs from the Water Board; an ROWD must be submitted to obtain the WDRs. Numerical Discharge limits would be based on MCLs, and the nondegradation policy in Resolution 68-16.	Groundwater	Potentially applicable to offsite discharges
Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California	Policy for implementing criteria for priority toxic pollutants contained in the California Toxics Rule promulgated by EPA as well as other priority toxic pollutant criteria and objectives. Criteria implemented through NPDES permit process. Applicable to discharges of treated groundwater to surface water.	Surface water	Applicable
Water Quality Monitoring and Response Programs for Solid Waste Management Units 27 CCR §20380 et seq.	The monitoring requirements apply to all determinations of alternative cleanup levels for unpermitted discharges to land of solid waste, pursuant to SWRCB Resolution No. 92-49, Section III.G. The provisions for Detection, Evaluation, and Corrective Action Monitoring requirements were developed for the purposes of detecting, characterizing, and responding to releases to groundwater, surface water, or the unsaturated vadose zone. For this removal, corrective action monitoring to demonstrate completion of the selected remedy at the Site would be relevant and appropriate and is further discussed in Corrective Action Program (27 CCR §20430).	Soil and groundwater	Relevant and appropriate
Concentration Limits 27 CCR §20400	Concentration limits must be established for groundwater, surface water, and the unsaturated zone. Must be based on background, equal to background, or for corrective actions, may be greater than background, not to exceed the lower of the applicable water quality objective or the concentration technologically or economically achievable. Specific factors must be considered in setting cleanup	Soil and groundwater	Relevant and appropriate

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
	standards above background levels. The specific factors have been addressed in SWRCB Resolution No. 92-49.		
Compliance Period 27 CCR §20410	Requires monitoring for compliance with remedial action objectives for years from the date of achieving cleanup standards.	Soil and groundwater	Relevant and appropriate
General Water Quality Monitoring and Systems Requirements 27 CCR §20415	Requires general soil, surface water, and groundwater monitoring. Applies to all areas at which waste has been discharged to land.	Soil and groundwater	Relevant and appropriate
Evaluation Monitoring Program 27 CCR §20425	Requires an assessment of the nature and extent of the release, including a determination of the spatial distribution and concentration of each constituent. The nature and extent of contamination is still being determined.	Soil and groundwater	To be determined
Corrective Action Program 27 CCR §20430	<p>Corrective action measures taken (for example, groundwater pump-and-treat system) may be terminated when the discharger demonstrates that all the COCs concentrations are reduced to levels below their respective concentration limits throughout the entire zone affected by the release.</p> <p>Corrective action completed when:</p> <ul style="list-style-type: none"> <li>• The concentration of each contaminant of concern in each sample from each monitoring point in the Corrective Action Program for the Unit has remained at or below its respective concentration limit during a proof period of at least one year, beginning immediately after the suspension of corrective action measures.</li> <li>• The individual sampling events for each monitoring point have been evenly distributed throughout the proof period and have consisted of no less than eight sampling events per year per monitoring point.</li> </ul> <p>The schedule to confirm attainment of cleanup levels appears relevant and appropriate.</p>	Soil and groundwater	Relevant and appropriate
Water Code §13140 40 CFR §131.12 Maintaining High Quality Water in California SWRCB Resolution No. 68-16	<p>The policy derives its authority to maintain the highest quality of water through waste discharge regulations to surface water and land implemented through the federal NPDES or California's Discharges of Waste to Land (27 CCR Division 2, Chapter 3), respectively.</p> <p>SWRCB Resolution No. 68-16 requires maintenance of existing state water quality using best practicable treatment technology unless a demonstrated change will benefit the people of California, will not unreasonably affect present or potential uses, and will not result in water quality less than that prescribed in other state policies.</p>	Groundwater	Applicable

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
	Applies to the discharge of waste to waters, including alternatives that include reinjection into the aquifer and discharges to soil that may affect surface water or groundwater. In situ cleanup levels for contaminated groundwaters must be set at background level, unless allowed. If degradation of waters is allowed to remain, the discharge must meet best practical treatment or control standards, and result in the highest water quality possible that is consistent with the maximum benefit to the people of the state. In no case may water quality objectives be exceeded.		
Sources of Drinking Water SWRCB Resolution No. 88-63	<p>This policy specifies that ground and surface waters of the state are either existing or potential sources of municipal and domestic supply except water supplies with one of the following:</p> <ul style="list-style-type: none"> <li>a. Total dissolved solids exceeding 3,000 mg/L</li> <li>b. Natural or anthropogenic contamination (unrelated to a specific pollution incident) that cannot reasonably be treated for domestic use using either BMPs or best economically achievable treatment practices, or</li> <li>c. The water source does not provide a sustained yield of 200 gpd.</li> </ul> <p>The requirement appears to be applicable because groundwater underlying the Site meets the criteria as a potential source for drinking water.</p>		Applicable
Fish & Game Code §3503	<p>This law prohibits take, possession, or needless destruction of any bird nests and eggs, except as provided by the Fish and Game Code or regulations.</p> <p>Implementation of the final remedy will comply with this requirement.</p>	Soil and groundwater	Applicable
California Hazardous Waste Control Law H&S Code Div. 20, Chap. 6.5	<p>The California law is more stringent than federal hazardous waste law and is applied to this Site. The following hazardous waste requirements are review for application to the Site.</p>	Evaluation of the Hazardous Waste Control Law provided below	Evaluation of the Hazardous Waste Control Law provided below
Identification and Listing of Hazardous Waste 22 CCR Div. 4.5, Chap. 11 22 CCR §66264.13 22 CCR §66260.200	<p>A generator must determine if the waste is classified as a hazardous waste in accordance with the criteria provided in these requirements. Waste characteristics of treated soil and groundwater will be defined prior to treatment and disposal. This methodology to characterize waste at the Site may result showing some of the waste identified at the Site meet the characteristics of hazardous waste. Any subsequent hazardous waste requirement would be relevant and appropriate or not an ARAR.</p>	Soil and groundwater	Applicable
Standards Applicable to Generators of Hazardous Waste	<p>Waste transport offsite for treatment or disposal must obtain and use a hazardous waste manifest and comply with the Department of Transportation packaging, labeling, marking, and placarding requirements. Waste may be accumulated onsite</p>	Soil and groundwater	Relevant and appropriate

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
22 CCR Div. 4.5, Chap. 12	for 90 days without a permit. Offsite actions and administrative requirements such as transport, manifesting, permitting, and record keeping are not applicable or relevant because ARARs address onsite activities.  The purpose of the 90-day storage limit is to prevent creating a greater environmental hazard than already exists at the Site. Waste contained onsite will be maintained in a container in good conditions (see Use and Management of Containers) prior to offsite disposal. EPA Region 9-approved CERCLA disposal facility must be used to dispose of CERCLA waste.		
Hazardous Waste Security 22 CCR §66264.14	Any proposed treatment facility is anticipated to maintain a fence in good repair that completely surrounds the active portion of the facility. A locked gate at the facility should restrict unauthorized personnel entrance. The security standards to prevent entry from unauthorized personnel for the proposed remedial treatment alternatives should be applied.	Soil and groundwater	Relevant and appropriate
Hazardous Waste Facility General Inspection Requirements and Personnel Training 22 CCR §66264.15 – 66264.16	The hazardous waste facility standards require routine facility inspections conducted by trained hazardous waste facility personnel. Inspections are to be conducted at a frequency to detect malfunctions and deterioration, operator errors, and discharges that may be causing or leading to a hazardous waste release and a threat to human health or the environment. Relevant to the proposed treatment facilities for this Site.	Soil and groundwater	Relevant and appropriate
Preparedness and Prevention 22 CCR Div. 4.5, Chap. 14, Art. 3	Facility design and operation to minimize potential fire, explosion, or unauthorized release of hazardous waste.	Soil and groundwater	Relevant and appropriate
Water Quality Monitoring and Response Systems for Permitted Systems 22 CCR Div. 4.5, Chap. 14, Art. 6	The requirements present the groundwater monitoring system objectives and standards to evaluate the effectiveness of the corrective action program (remedial activities). After completion of the remedial activities and closure of the facility, groundwater monitoring will continue for additional years to ensure attainment of the remedial action objectives. This requirement is similar to 27 CCR §20410. Groundwater monitoring considered for the remedial alternatives.	Groundwater	Relevant and appropriate
Closure and Post-Closure 22 CCR Div. 4.5, Chap. 14, Art. 7	The closure and post-closure requirements establish standards to minimize maintenance after facility closure to protect human health and the environment. The closure and post-closure requirements may be dependent upon the treatment alternatives. Clean closure of the treatment facility through equipment decontamination and removal of any hazardous waste is anticipated.	Soil and groundwater	Relevant and appropriate

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
Use and Management of Containers 22 CCR Div. 4.5, Chap. 14, Art. 9	Maintain container and dispose to a Class I hazardous waste disposal facility within 90 days. Storage of investigation-derived waste (soil cuttings and well development) will be generated. Requirements may apply for the storage of contaminated groundwater and sediments trapped by the bag filter during startup operation. The 90-day storage limit is to not create a greater environmental hazard than already exists. Maintaining the containers in good conditions at all times and not creating an environmental hazard is relevant and appropriate.	Soil and groundwater	Relevant and appropriate
Tank Systems 22 CCR Div. 4.5, Chap. 14, Art. 10	Minimum design standards (shell strength, foundation, structural support, pressure controls, and seismic considerations) for tank and ancillary equipment are established. The requirements for minimum shell thickness and pressure controls to prevent collapse or rupture is to not create a greater environmental hazard than already exists. The requirements are relevant and appropriate for the proposed treatment alternatives (22 CCR§ 66264.193).	Groundwater	Relevant and appropriate
Incinerators 22 CCR Div. 4.5, Chap. 14, Art. 15	Substantive performance standards, operation, operational monitoring, closure requirements for incinerators. Site-related contamination may be hazardous waste; however, not at levels required appropriate for this regulation.	Soil and groundwater	<u><b>To be determined</b></u>
Corrective Action for Waste Management Units 22 CCR Div. 4.5, Chap. 14, Art. 15.5	Establishes placement, consolidation, and treatment of soils and wastes being generated as part of a corrective action under Resource Conservation and Recovery Act (RCRA) and will not be considered a new disposal to land as long as the materials are handled in a CAMU.	Soil and groundwater	<u><b>To be determined</b></u>
Miscellaneous Units Requirements 22 CCR Div. 4.5, Chap. 14, Art. 16 22 CCR §66264.601 – 66264.603	Minimum performance standards are established for miscellaneous equipment to protect health and the environment. Treatment of hazardous waste through an air stripper or GAC would qualify as a RCRA miscellaneous unit if the contaminated water constituted a hazardous waste. Therefore, the substantive requirements for miscellaneous units and related substantive closure requirements may be relevant and appropriate for the Site.	Soil and groundwater	Relevant and appropriate
Land Disposal Restrictions Schedule for Land Disposal Prohibition and Establishment of Treatment Standards 22 CCR Div. 4.5, Chap. 18, Art. 2	Provides a list of waste subject to land disposal restrictions. Only relevant if excavated wastes are classified as hazardous waste and disposed or treated ex situ and onsite outside the CAMU-designated area.	Soil and groundwater	<u><b>To be determined</b></u>

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
Land Disposal Restrictions Prohibition on Land Disposal 22 CCR Div. 4.5, Chap. 18, Art. 3	Provides waste-specific land disposal restrictions for solvent waste, dioxin-containing wastes, and California-Listed waste. Only relevant if excavated wastes are classified as hazardous waste and disposed or treated ex situ and onsite outside the CAMU-designated area.	Soil and groundwater	<u>To be determined</u>
Land Disposal Restrictions Treatment Standards 22 CCR Div. 4.5, Chap. 18, Art. 4	Provides treatment standards expressed in contaminant concentrations in waste extract, specified technologies, and waste treatment concentrations. Only relevant if excavated wastes are classified as hazardous wastes and disposed or treated ex situ and onsite outside the CAMU-designated area.	Soil and groundwater	<u>To be determined</u>
Land Disposal Restrictions Prohibition on Storage 22 CCR Div. 4.5, Chap. 18, Art. 5	Provides prohibition on storage of restricted waste. Only relevant if excavated wastes are classified as hazardous wastes and disposed or treated ex situ and onsite outside the CAMU-designated area.	Soil and groundwater	<u>To be determined</u>
Land Disposal Restrictions Land Disposal Prohibitions – Non-RCRA Wastes 22 CCR Div. 4.5, Chap. 18, Art. 10	The requirements establish hazardous waste disposal standards through numerical treatment limitations and treatment technologies. Only relevant if excavated wastes are classified as hazardous wastes and disposed or treated ex situ and onsite outside the CAMU-designated area.	Soil and groundwater	<u>To be determined</u>
Land Disposal Restrictions Treatment Standards – Non-RCRA Waste Categories 22 CCR Div. 4.5, Chap. 18, Art. 11	The requirements establish hazardous waste disposal standards through numerical treatment limitations and treatment technologies. Only applicable or relevant if excavated wastes are classified as hazardous wastes and disposed or treated ex situ and onsite outside the CAMU-designated area.	Soil and groundwater	<u>To be determined</u>
South Coast Air Quality Management District (SCAQMD) Rules and Regulations	The SCAQMD regulations are established to achieve and maintain state and federal ambient air quality standards through the federal-approved state implementation plan (SIP).	Evaluation of SCAQMD rules and regulations provided below	Evaluation of SCAQMD rules and regulations provided below
Regulation IV, Rule 401, Visible Emissions	Prohibitions on gross visible smoke emission exceeding Ringlemann standards, open burning, burn refuse, gross SO <sub>x</sub> and PM combustion contaminants, organic solvent emissions, SO <sub>x</sub> , NO <sub>x</sub> , and PM emissions from generators, circumvention of rules, and storage of organic liquids.	Soil and groundwater	Applicable

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
Regulation IV, Rule 402, Nuisance	A person shall not discharge from any source whatsoever such quantities of air contaminants or other material that cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public or that endanger the comfort, repose, health, or safety of any such persons or the public or that cause to have a natural tendency to cause injury or damage to business or property.	Soil and groundwater	Applicable
Regulation IV, Rule 403, Fugitive Dust	Emissions of fugitive dust shall not remain visible in the atmosphere beyond the property line of the emission source. Activities conducted in the South Coast Air Basin shall use best available control measures to minimize fugitive dust emissions and take necessary steps to prevent the trackout of bulk material onto public paved roadways as a result of their operations.	Soil	Applicable
Regulation IV, Rule 404, Particulate Matter – Concentration	Particulate matter in excess of the concentration standard conditions shall not be discharged from any source. Particulate matter in excess of 450 mg/m <sup>3</sup> (0.196 grain per cubic foot) in discharged gas, calculated as dry gas at standard conditions, shall not be discharged to the atmosphere from any source.	Soil and groundwater	Applicable
Regulation IV, Rule 405, Solid Particulate Matter – Weight	Solid particulate matter including lead and lead compounds discharged into the atmosphere from any source shall not exceed the rates Table 450(a) of Rule 405. Nor shall solid particulate matter including lead and lead compounds in excess of 0.23 kg (0.5 lb) per 907 kg (2,000 lb) of process weight be discharged to the atmosphere. Emissions shall be averaged over one complete cycle of operation or 1 hour, whichever is the lesser time period.	Soil	Applicable
Regulation XIII, Rule 1303 – New Source Review	Construction for any relocation or for any new or modified source that results in an emission increase of any nonattainment air contaminant, any ozone-depleting compound, or ammonia must include BACT for the new or relocated source or for the actual modification to an existing source. This requirement would apply to treatment technologies with potential to emit primary pollutant(s) to the atmosphere.	Soil and groundwater	Applicable
Regulation XIV, Rule 1401, New Source of Toxic Air Contaminants.	Construction or reconstruction of major stationary source emitting hazardous air pollutants shall be constructed with Best Available Control Technology for Toxics (T-BACT) and comply with all other applicable requirements.	Soil and groundwater	Applicable

TABLE 2-2  
Potential Applicable or Relevant and Appropriate Requirements  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
POTW Requirements	Treated effluent discharge to reclaimed water line and brine discharge to sanitary sewer will need to comply with any requirements set forth by the current POTW owner: Central Basin Municipal Water District	Groundwater	Applicable

Notes:

ARAR = Applicable or Relevant and Appropriate Requirement  
 BACT = Best Available Control Technology  
 BAT = Best Available Technology  
 CAMU = Corrective Action Management Unit  
 CDFG = California Department of Fish and Game  
 CEQA = California Environmental Quality Act  
 CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980  
 COC = contaminant of concern  
 EPA = United States Environmental Protection Agency  
 ESA = Endangered Species Act  
 GAC = granulated activated carbon  
 gpd = gallons per day  
 kg = kilogram  
 MCL = maximum concentration level  
 mg/L = milligrams per liter  
 NL = Notification Level  
 NOx = nitrogen oxides  
 NPDES = National Pollutant Discharge Elimination System  
 PM = particulate matter  
 POTW = Publicly Owned Treatment Works  
 RCRA = Resource Conservation and Recovery Act  
 ROWD = Report of Waste Discharge  
 RWQCB = Regional Water Quality Control Board  
 SCAQMD = South Coast Air Quality Management District  
 SIP = state implementation plan  
 Sox = sulfur oxides  
 SWAT = Solid Waste Assessment Test  
 T-BACT = Best Available Control Technology for Toxics  
 VOC = volatile organic compound  
 WDR = waste discharge requirements  
 WQO = water quality objectives



TABLE 2-2A  
To-Be-Considered Documents  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
<b>TO-BE-CONSIDERED DOCUMENTS</b>			
The Designated Level Methodology for Waste Classification and Cleanup Level Determination	Provides guidance on how to classify wastes to meet SWRCB hazardous waste management requirements (23 CCR Div. 3, Chap. 15, Art. 2) and designated, nonhazardous, and inert waste management requirements (27 CCR Div. 2, Subdiv. 1, Chap. 3, Subchap. 2, Art. 2). Considered to evaluate control of contaminants in the vadose zone.	Soil and groundwater	To be considered
California Notification Levels	NLs are health-based advisory levels established by the California Department of Health Services for contaminants that lack primary MCLs. NLs are advisory levels and not enforceable standards. An NL is the level of a contaminant in drinking water that is considered not to pose a significant health risk to people ingesting that water on a daily basis. It is calculated using standard risk assessment methods for noncancer and cancer endpoints, and typical exposure assumptions, including a 2-liter-per-day ingestion rate, a 70-kilogram adult body weight, and a 70-year lifetime. For 1,4-dioxane, a chemical considered a probable carcinogen and a COC at the Site, the NL is generally a level considered to pose “de minimis” risk (that is, a theoretical lifetime increase in risk of up to one excess case of cancer in a population of 1,000,000 people—the 10E-6 risk level). Table 2-1 provides the NL for 1,4-dioxane.	Groundwater	To be considered
California Well Standards California Department of Water Resources Bulletin 74-90	This is a supplement to Bulletin 74-81 (domestic water well standards) that addresses minimum specifications for monitoring wells, extractions wells, injection wells, and exploratory borings. Design and construction specifications are considered for construction and destruction of wells and borings.	Soil and groundwater	To be considered
Fish and Game Commission Wetlands Policy (adopted 1987) included in Fish and Game Code Addenda	This policy seeks to provide for the protection, preservation, restoration, enhancement, and expansion of wetland habitat in California. Further, it opposes any development or conversion of wetland that would result in a reduction of wetland acreage or habitat value. It adopts the USFWS definition of a wetland, which uses hydric soils, saturation or inundation, and vegetation criteria, and requires the presence of at least one of these criteria (rather than all three) to classify an area as a wetland. This policy is not a regulatory program and should be included as a TBC.		To be considered
California Department of Public Health Policy Guidance for Direct Domestic Use of Extremely Impaired Sources (Policy 97-005)	This policy establishes a process, including permitting, that must be followed before using an extremely impaired water source as a drinking water supply. This policy is not a promulgated requirement and should be included as a TBC.	Groundwater	To be considered

TABLE 2-2A  
To-Be-Considered Documents  
*Omega Chemical Corporation Superfund Site*

Requirements	Description	Media	Applicable or Relevant and Appropriate
Los Angeles Regional Water Quality Control Board	The regional board is enforcing a hexavalent chromium limit of 8 µg/L for discharges into the Los Angeles River compared to the CTR limit of 11 µg/L; it is assumed the LARWQCB will have similar restrictions for other rivers in the region.	Groundwater	To be considered
City of Burbank and Glendale	These agencies are voluntarily abiding by a discharge limit of 5 µg/L hexavalent chromium for potable water even though there is no MCL for this compound, only for total chromium.	Groundwater	To be considered

Notes:

LARWQCB = Los Angeles Regional Water Resources Control Board

MCL = maximum concentration level

µg/L = microgram per liter

NL = Notification Level

USFWS = United States Fish and Wildlife Service

**TABLE 2-3**  
Summary of General Response Actions and Screening of Remedial Technologies and Process and End Use Options  
*Feasibility Study Report for Omega Chemical Superfund Site in Whittier, California*

General Response Action	Remedial Technology & Discharge or End Use	Process Or End Use Option	Description	Effectiveness	Implementability	Relative Cost	Screening Comments	Retained Y/N
No Action	None	None	The no-action general response action is required by U.S. Environmental Protection Agency (EPA) guidance (EPA, 1988) as a baseline for comparison with other remedial alternatives.	Low	High	Low	The no-action option does not include active remediation or monitoring; retained per EPA requirements.	Y
Institutional Controls		Ban on New Production Wells	Legal or physical means to prevent potential exposure to chemicals of concern by limiting the use of contaminated water.	Low	Moderate	Low	Institutional controls will likely be part of all remedial action alternatives.	Y
		Notifications to Potential Receptors of Risk	Commonly used action to make public aware of potential risk.	Low	High	Low		
Monitoring			Monitoring of groundwater at Operable Unit (OU) 2, physical conditions in the OU2 area, performance of remedial systems, and industrial and development activities that could potentially impact the OU2 remedy.	High	High	Moderate	Monitoring will be part of all remedial action alternatives.	Y
Containment <sup>(1)</sup>	Groundwater Extraction	New Extraction Wells	This response action reduces the mobility of chemicals, eliminates exposure pathways, and prevents the migration of contamination in groundwater into yet unimpacted aquifer zones; extraction wells may be located near the downgradient edge of contaminated plumes as well as, or in addition to, extraction wells near contamination "hot" zones.	Moderate	High	High	Commonly used method to contain contaminant migration in aquifers.	Y
	Surface Water Controls	Stormwater Routing	Includes existing measures and facilities for preventing the infiltration of surface water into the contaminated aquifers at OU2.	Moderate	High	Low	Reliance on existing surface water controls will likely be part of most remedial alternatives by default.	Y
	Physical Barriers	Slurry Walls, Grout Curtains, Sheet Piling	Physical containment barriers designed to prevent or minimize movement of groundwater past the barrier structures.	Low	Low	High	Installation limited to approximate 100-foot depth while contamination at OU2 extends to about 200 feet below ground surface; mounding of water behind barriers can divert groundwater to other areas.	N
Ex Situ Groundwater Cleanup	Extracted Groundwater Treatment	Air Stripping	Use packed tower aeration, low-profile aeration, bubble diffusion, or aspiration or centrifugal stripping to remove contaminants of concern (COCs).	High	High	Moderate to High	Commonly used for VOC treatment; not effective for all contaminants such as perchlorate, hexavalent chrome, etc.; very simple system; commonly used as a component of a remedial alternative; may require off-gas treatment with VGAC or oxidizer.	Y
		Liquid-Phase Granular Activated Carbon (LGAC) Adsorption	Many COC constituents are attached to the internal surface of activated carbon.	High	High	Moderate	Commonly used for VOC treatment; not effective for all contaminants such as perchlorate, hexavalent chrome, etc.; very simple system; commonly used as a component of a remedial alternative.	Y
		Biological Liquid-phase Granular Activated Carbon (Bio-LGAC) Adsorption	The process allows limited buildup of a biological film that can remove a range of VOCs not easily treated by LGAC alone. The Bio-LGAC system needs to be cleaned periodically by backwashing; however, the carbon does not need to be replaced.	High	High	Moderate	Commonly used for VOC treatment; not effective for all contaminants such as perchlorate, hexavalent chrome, etc.; very simple system; commonly used as a component of a remedial alternative.	Y
		Advanced Oxidation Process	Use ultraviolet (UV) light or ozone and a chemical oxidant, which react to form hydroxyl radicals. AOP technology is potentially effective for the removal of 1,4-dioxane, NDMA, and many VOCs.	High	High	High	Effective for 1,4-dioxane and alkane VOCs, but generally more expensive; may require downstream Bio-LGAC or conventional LGAC to treat oxidation by-products that may be formed.	Y
		Ion Exchange	Potentially applicable for the removal of perchlorate and hexavalent chromium. Extracted water is filtered to remove any suspended solids and passed through a vessel containing a chloride-based anion exchange resin.	High	High	Moderate to High	Effective technology; however, cost can be driven by presence of other constituents that may compete for the resin.	Y

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General Response Action	Remedial Technology & Discharge or End Use	Process Or End Use Option	Description	Effectiveness	Implementability	Relative Cost	Screening Comments	Retained Y/N
		Biological Treatment	Add nutrients to extracted water to sustain microbes that are capable of anaerobic degradation. Potentially effective for the removal of perchlorate and many VOCs; can be operated anaerobically, or aerobically or both using separate compartments.	High	High	Moderate to High	Commonly used for perchlorate and VOC treatment.	Y
		Membrane Processes (Reverse Osmosis, Nanofiltration, etc.)	Applicable to remove dissolved solids and other contaminants. Uses a semi-permeable membrane that allows certain constituents to pass through while blocking others.	High	High	High	May also remove other dissolved salts. Membranes create a concentrated waste stream requiring further treatment and/or disposal. May be required to improve water quality for potable, reclaim, spreading basin, or reinjection uses.	Y
		Evaporation / Condensation	Applicable for removing potentially all dissolved solids and other contaminants to produce high distillate quality water.	High	High	Very High	Requires very costly equipment and is very energy intensive and because electrical power drives the evaporation process.	N
		Ferrous Iron Reduction with Filtration	Potentially applicable for the removal of hexavalent chromium. Chemically reduces hexavalent chromium to trivalent chromium and co-precipitating trivalent chromium with ferric iron. Typically requires solids removal and solids sludge handling systems.	High	High	Moderate	Effective for hexavalent chromium reduction. Would need to be coupled with other technologies to remove other contaminants.	Y
		Ancillary Groundwater Treatment Technologies	May be used in conjunction with the other technologies for completion of a comprehensive treatment system; includes multimedia filters, catalytic carbon adsorbers, vapor phase GAC, vapor thermal oxidation, injection of various water conditioning chemicals, biological filters, or vapor refrigeration/condensation processes.	Moderate to High	Moderate	Moderate to High	One or more of these ancillary technologies will be part of some of the remedial actions.	Y
		Disinfection	Disinfection of Treated Water. Add various disinfecting chemicals such as chlorine, ozone, chlorine dioxide, chloramine, peroxone (ozone/hydrogen peroxide), and/or ultraviolet (UV) irradiation for potable water or reinjection treated water end uses.	High	High	Moderate to High	Would be required for any potable or reclaimed water use options.	Y
	Treated Water Discharge or End Use Options	Potable Water End Use	Discharge treated water to existing water purveyors.	High	High	Moderate	Consistent with water conservation in current draught conditions; requires extensive drinking water-related permitting; can connect to existing nearby potable water infrastructure.	Y
		Spreading Basins	Discharge to local spreading basins for aquifer recharge.	High	Low to moderate	Moderate to High	Requires complex and extensive permitting with many agencies; treatment may be complex to meet discharge standards; basins may not be available for extended periods of time due to basin maintenance; long pipeline to basins may be required; provides regional water reuse benefit because it would allow LACSD to send more reclamation water from San Jose Creek Water Reclamation Plant while still complying with mandated natural/dilution water to reclamation water ratios in spreading basins.	Y

**TABLE 2-3**  
 Summary of General Response Actions and Screening of Remedial Technologies and Process and End Use Options  
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General Response Action	Remedial Technology & Discharge or End Use	Process Or End Use Option	Description	Effectiveness	Implementability	Relative Cost	Screening Comments	Retained Y/N
		Shallow Injection	Discharge into shallow injection wells outside of the OU2 plume.	High	Low	Moderate to High	Although this option would be relatively easy to implement physically, it would be very complex in terms of potential interference with other remedial efforts (source control systems within OU2 and at sites outside OU2); difficult to implement because extensive permitting and agency approvals, as well as negotiations with parties responsible for other potentially affected remedial systems would be required; relatively moderate to high in cost because injection wells would have to be installed far from the treatment plant(s), which would increase the conveyance pipeline costs.	N
		Deep Reinjection	Discharge into deep reinjection wells in OU2 for aquifer recharge.	High	Moderate	High	Consistent with water conservation in current draught conditions; requires extensive permitting; treatment costs can be high to avoid aquifer degradation; injection wells can be located near treatment plant to minimize treated water conveyance.	Y
		Storm Drain	Discharge to storm drain.	High	Low	Moderate to High	Would require NPDES permitting; treatment may be complex to meet discharge standards; high compensation would be required for water rights; not consistent with water conservation in current draught conditions.	N
		POTW	Discharge to sewer for POTW treatment.	High	Low	High	Requires minimal treatment; local POTW agency policy is not to accept treated water due to POTW capacity concerns; high compensation would be required for water rights; high cost for sewer connection fees; not consistent with water conservation in current draught conditions. (Although not for treated water discharge, this option will be retained to be able to discharge relatively small wastewater streams that may be generated from treatment technologies such as reverse osmosis, equipment cleaning operations, etc.)	N
		Reclaimed Water	Discharge to recycled (RECLAIM) water system for industrial water supply or irrigation use.	High	Moderate	Moderate	Requires multiple agency approvals and coordination; existing reclaim pipelines are in the area; reuse will likely mitigate water rights because water will be reused in same water basin; flow rate may temporarily exceed demand; current reclaimed water demand may be too low to handle GWTP discharge.	Y

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General Response Action	Remedial Technology & Discharge or End Use	Process Or End Use Option	Description	Effectiveness	Implementability	Relative Cost	Screening Comments	Retained Y/N
In Situ Groundwater Cleanup	In Situ Groundwater Treatment	Biological-Natural Attenuation	Treatment of contaminants by natural processes.	Low	Low to Moderate	Low	Not contaminants treatable by natural attenuation; remediation duration would be more prolonged; would be part of most remedial actions by default because some level of natural attenuation would always be occurring.	Y
		Biological-Active In Situ	Treatment of contaminants by injection of gasses and/or nutrients (and sometimes microorganisms) to stimulate subsurface biodegradation of contaminants; can be either aerobic or anaerobic; not practical if plume is large and wide range of contaminant types are present.	Low	Moderate	Moderate	Treatment would not be able to treat the wide range of contaminants in the groundwater.	N
		Chemical Processes	Chemical oxidation by injecting oxidizing agents such as hydrogen peroxide, sodium persulfate, or sodium permanganate through a series of injection wells or trenches, or both.	Low	Moderate	Moderate to High	Best suited for localized areas of high concentrations, which are not present in the groundwater plume.	N
		Thermal Processes	Thermal processes commonly use steam injection, hot gas injection, or electrical resistance heating to volatilize contaminants; often combined with SVE.	Low	Low	Very High	Not well suited for large volumes of water over a large area; energy requirements would be prohibitively high.	N
		Physical Processes	Physical processes such as air sparging (AS) with soil vapor extraction (SVE) are commonly accomplished with air sparge wells, compressors, vacuum blowers, and vapor extraction wells. Collected and contaminated vapors would require treatment prior to discharge to the atmosphere.	Low	Low	Very High	Not well suited for large volume of water over a large area; cost would be prohibitive.	N

(1) Ongoing and planned future source reduction and/or source control measures under EPA oversight at OU1 and at approximately 20 source areas identified in the RI that are under state oversight are implicitly included for any remedial alternative to be developed. No additional source reduction and/or source control measures are included in this OU2 Feasibility Study.

## 3. Development of Alternatives

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This section further screens technologies and process options to select a representative technology or process option when more than one is potentially viable, and describes alternatives that were developed using a combination of the remedial technologies and representative process options that were identified and retained after the screening process described in Section 2. These retained technologies and process options are further evaluated and screened qualitatively against the three main criteria (effectiveness, implementability, and cost), such that a representative technology or process option can be selected for development of remedial alternatives when more than one technology or process option is available. Remedial alternatives are formulated by combining the selected technologies and representative process options.

### 3.1 Approach to Alternative Development

EPA guidance (EPA 1988) requires that a No-Action Alternative be considered and compared to the Action alternatives. The No-Action Alternative does not include active remediation, institutional controls (ICs) or monitoring at OU2. Other than the No-Action Alternative, the active remedial alternatives are formulated by assembling the remedial technologies and process options related to the containment and treatment response actions. Each of the active alternatives also incorporates institutional controls and monitoring.

### 3.2 Screening of Remedial Technologies and Process Options

The GRAs, remedial technologies, and process options deemed to be potentially applicable for the OU2 are further screened and evaluated in this section. Screening was done qualitatively on the basis of effectiveness (primarily), implementability, and relative cost. This section also includes an evaluation of having a single centralized groundwater treatment plant versus multiple plants for those scenarios where there are multiple extraction well areas.

The effectiveness analysis is based on the relative merits of a process option when compared to other process options within the same technology type and focuses on the following factors:

- The potential effectiveness of a process option to meet the goals identified in the RAOs
- The potential impacts to human health and the environment during the construction and implementation phases
- Reliability and success of the process with respect to the types of contamination and Omega OU2 conditions that will be encountered

Implementability analysis focuses on the technical and administrative feasibility of the process option, such as the ability to obtain necessary permits (if any); the availability and

capacity of treatment, storage, and disposal services; and the availability of the equipment and workers to implement the technology.

Cost plays a limited role in the screening of process options. Each process is qualitatively evaluated based on its costs being relatively high, medium, or low. Relative capital plus O&M costs were used rather than detailed estimates.

When multiple process options are considered effective, implementable, and cost-effective, a representative process option will be chosen and used in the development and analysis of remedial alternatives. In such cases, the selection of the actual process option to be implemented is deferred to the remedial design phase.

### 3.2.1 Common Elements

This section discusses the GRAs that are common to all remedial alternatives except the No-Action Alternative, including institutional controls and monitoring.

ICs are non-engineering controls that will supplement engineering controls to prevent or limit potential exposure to hazardous substances, pollutants, or contaminants and to ensure that the remedy is effective.

Groundwater in and in the vicinity of OU2 is an important source of drinking water. The groundwater contamination in OU2 potentially limits the ability of numerous water rights holders to fully exercise their water rights, and it also could create a significant challenge for certain rights holders to operate their production wells in a manner that is compatible with the groundwater contamination containment goals of the OU2 interim remedy.

While the well permit requirements, drinking water regulatory controls, and the Watermaster's authority to regulate and allocate water resources ensure a degree of control over the extraction and use of OU2 area groundwater, these existing controls may not be adequate to ensure that water rights holders are adequately informed about the scope and status of the OU2 plume and the selected OU2 remedy. Without such information, these water rights holders may inadvertently operate their production wells (and/or install new wells) in a manner that is incompatible with the containment and human health protection goals of the selected remedy.

As discussed in Section 2.5.2, the ICs that are retained for the OU2 interim remedial action are essentially informational ICs. They include 1) annual notifications to water rights holders in the Central Basin and other stakeholders, and 2) periodic meetings with State and local agencies with jurisdiction over well drilling and groundwater use within the Central Basin.

The annual notification to be provided to all water rights holders in the Central Basin would explain (1) the goals of the selected interim OU2 groundwater, the status of the remedy's implementation, and the nature and extent of OU2 groundwater contamination; and (2) any related State or local restrictions and prohibitions on well-drilling and groundwater use without necessary approvals and permits.

The periodic (e.g., annual) meetings among EPA and State and local entities with jurisdiction over well drilling and groundwater use within the Central Basin would include

the Watermaster, LACDHS, and the Cities of Whittier, Santa Fe Springs and Norwalk. The purpose of the meetings would be to periodically exchange all available information relevant to whether operation of any production well(s) within OU2 or its vicinity is incompatible with the groundwater contamination containment goals of the interim remedial action. Such information would include any permit(s) for well installation that had been applied for or granted in the OU2 area or vicinity and the compatibility of such permit(s) with the RAOs of the interim remedy selected in the OU2 ROD.

These meetings would be supplemented by an annual review of available documentation maintained by the State and local entities to determine if water supply wells have been installed, or a purveyor or other water rights holder had increased groundwater production or production capacity within OU2 or its vicinity.

If any information exchanged pursuant to the meeting or obtained through the documentation review suggested a possible incompatibility between the operation of production wells and the groundwater contamination containment goals of the interim OU2 remedial action, prompt notification to EPA would be provided, if not previously provided. Thereafter, EPA would take such actions it determines are necessary or appropriate to assure that such permit or authorization does not create a risk to human health or the environment, or impair or delay any response action for the Omega Site.

The information exchange provided by these ICs would protect public health by reducing the possibility that production wells in the vicinity of OU2 could become contaminated, and also reducing the possibility that operation of production wells would interfere with the plume containment goals of the interim OU2 remedy.

**Monitoring** of water levels and groundwater quality would allow for assessment of continued contaminant migration in aquifer. In addition, groundwater monitoring is also needed to evaluate the effectiveness of the implemented remedy. Therefore, groundwater monitoring will be an integral part of all active remedial alternatives. The monitoring network for an OU2 remedy would likely consist of both the existing Omega monitoring wells (i.e., OU2 Wells MW1 to MW31 and OU1 and OU2 Wells OW1 to OW9) and additional new monitoring wells to be installed as described for each remedial alternative.

## 3.2.2 Containment Options

### 3.2.2.1 Description

Containment of contaminated groundwater in OU2 can prevent further contaminant migration. The only viable remedial technology option retained from Section 2 that provides hydraulic control needed to meet the containment goal is control of the groundwater gradient via groundwater extraction. This can be achieved by placing extraction wells downgradient of the contaminated area. Depending on their location and design, existing groundwater extraction wells, such as municipal water supply wells, might also be suitable to achieve containment.

Two containment scenarios were considered during the development of the FS alternatives for OU2. The first scenario (leading-edge extraction scenario) proposes extracting contaminated groundwater only from the contaminated aquifer at the leading edge of OU2

to prevent contaminants from migrating into the uncontaminated downgradient area. The second scenario proposes plumewide extraction where containment wells are placed at multiple locations distributed throughout the entire OU2 plume to prevent the spreading of high-concentration zones and control vertical migration of contaminants in addition to the goal under the first capture scenario. For the plumewide extraction scenario, different numbers of extraction locations can be assumed to achieve the containment goal. For the purpose of FS analysis, three general extraction locations are assumed – the leading edge area (LE) extraction; central area (CE) extraction, which is located near MW26; and the northern area (NE) extraction, which is located near MW23. Furthermore, each of these locations can have one or more extraction wells.

A third scenario (high-concentration zone extraction only) was also considered but was not carried forward for alternatives development. This scenario was based on extraction of water only from the higher contaminant concentration zones, namely at CE and NE. This extraction scenario would require the same overall extraction rates as the first two scenarios to capture the entire plume width, and as a result the capital and O&M costs for a given end use would be roughly comparable to similar alternatives using the plumewide extraction scenario. In addition, extraction in the high concentration zones only would provide less control over the migration of COCs to domestic water production wells compared to the first two extraction scenarios because a significant portion of the plume would not be captured. In light of the very limited potential cost savings, the potential for adverse impacts on downgradient production wells and the fact that the plume would spread into uncontaminated aquifer zones downgradient of the CE location, an alternative with extraction only in the CE and NE areas was not developed in this FS.

A numerical groundwater flow model was used to estimate the minimum extraction rates needed to achieve containment under the two pumping scenarios. The targeted area of hydraulic containment is the footprint of the OU2 plume, and the targeted depth is the observed contaminated portion of the OU2 aquifer; that is, to a depth of about 200 feet bgs. For the leading-edge extraction scenario, the modeling indicates that two extraction wells with a combined extraction rate of 1,150 gpm at the LE location are required to prevent further downgradient migration of contaminated groundwater. For the plumewide extraction scenario, the model estimates that a combined extraction rate of 1,300 gpm is required to mitigate migration of contaminated groundwater, with CE and NE areas at 350 gpm each and LE extraction area at 600 gpm. Detailed descriptions of the groundwater modeling conducted for the FS can be found in Appendix A.

For this FS analysis, a safety factor of about 50 percent was applied to the extraction rates predicted by the numerical model. The extraction rates used in the model are the minimum rates necessary to achieve plume capture in the model. Higher design extraction rates are used in the FS because of uncertainty in the aquifer properties, contaminant distribution, and future groundwater conditions. Specifically, the LE extraction scenario assumes three representative extraction wells at the LE extraction area with extraction rates of 600 gpm each for a total extraction rate of 1,800 gpm. The plumewide extraction scenario assumes two CE wells with an extraction rate of 250 gpm each, two NE wells with an extraction rate of 250 gpm each, and three LE wells with an extraction rate of 350 gpm each; the total extraction rate is 2,050 gpm for the plumewide extraction.

It is noted that five active production wells are located in the vicinity of OU2, (see Figure 1-3) including SFS #1 and the four wells owned by the GSWC (Pioneer #1, Pioneer #2, Pioneer #3, and Dace #1). All of these production wells are currently equipped with wellhead treatment units. The modeling conducted to evaluate the pumping scenarios assumed continued operation of these production wells at their currently reported average production rate. Of particular importance are the GSWC Wells Pioneer #1, Pioneer #2, and Pioneer #3, located to the west side of OU2 LE. The modeling indicates that these wells are capturing some of the contaminated groundwater from OU2 and currently are providing some degree of the containment at the leading edge. The remedy would have to account for the operation of these production wells, as discussed in Section 4.

It is also noted that extraction is represented in this FS on a conceptual level. For example, in the model, a single extraction well is used to represent groundwater extraction at each of the NE and CE locations and two wells are used at the LE location; however, the actual system would be implemented using multiple wells at each extraction location. Furthermore, the plumewide pumping scenario with extraction from three proposed locations is a simplified representation of a system consisting of multiple extraction wells at each of the three general locations (LE, CE, and NE). An extraction system with different numbers of extraction locations with a similar combined extraction rate would also be able to achieve the containment goal. The optimum number of wells and their locations will be further analyzed during the remedial design.

### 3.2.2.2 Evaluation

Extraction wells are commonly used as a means to influence groundwater flow to achieve containment. In addition, an extraction and treatment system will also reduce the contaminant mass in the aquifer over time.

The Central Basin is an adjudicated basin in which groundwater use is restricted to the allowed pumping allocations by a California Superior Court Judgment and monitored by a court-appointed Watermaster; therefore, water rights have to be considered for any alternative involving groundwater withdrawal. The application of the water rights is discussed in the next subsection for each potential end use option.

For Omega OU2, extraction at the LE area is necessary to meet the RAO of preventing plume migration further downgradient, and will be retained for all alternatives. However, pumping at the LE area only does not meet all the RAOs. Specifically, it would allow some high COC concentrations within the OU2 plume to migrate into groundwater with lower VOC concentrations in other areas of the plume. This extraction scenario is retained for detailed evaluation as part of the remedial alternatives. In general, extracted water under the LE extraction-only scenario would have a different composition of contaminant concentrations in the influent compared to the COC mix in groundwater extracted from the CE and NE locations. For example, immediately following the startup of the remedial system, the concentrations in the extracted water from the LE extraction-only scenario will initially be relatively low but will increase over time as more contamination is drawn into the LE area. This is in contrast with the plumewide extraction scenario in which initial groundwater concentrations will be relatively high but will decrease over time.

Plumewide extraction at LE, CE, and NE may allow for different treatment technologies and end uses for the groundwater extracted from these areas. Plumewide extraction effectively prevents spreading of highly contaminated groundwater into relatively less contaminated groundwater within the plume, as well as downgradient of the plume. This option will also provide more flexibility for an effective adjustment of the extraction system to maintain containment, should conditions in the basin change. This extraction scenario is retained for detailed evaluation as part of the remedial alternatives.

The existing production wells at and near OU2 (including the impacted wells) are not well suited to serve as remedy extraction wells because they are not optimally located (at the plume edges rather than at the high concentration zone) and constructed (the screens are too deep) for providing efficient plume capture. The impacted wells are expected to continue to capture a portion of the contamination under both pumping schemes considered. However, the extraction system for the OU2 remedy will prevent further degradation of the wells by capturing most of the plume. The protection of the production wells is an important factor in achieving the RAOs and will be further considered in the development and evaluation of alternatives.

### 3.2.3 End Use Options

#### 3.2.3.1 Description

As indicated in Section 2 of this FS, end use options, including drinking water, reclaimed water, reinjection, and spreading basin infiltration, are retained for development of alternatives. Refer to Section 2 for details on these end use options.

#### 3.2.3.2 Evaluation

Alternatives that include groundwater extraction must address water rights as discussed in Section 2 because OU2 is located within an adjudicated basin. The water rights issues are discussed in the following pages for each end use option.

All of the potential end uses considered in Section 2, including drinking water, reinjection, reclaimed water, and spreading basins discharge, will have an associated brine wastewater stream with high TDS levels. This brine will have to be separated and discharged to a sewer.

#### Drinking Water

This option has moderate implementability, high effectiveness, and high cost. The treated water would be used for a beneficial purpose and would be desirable in the current drought situation. Technically, it is highly implementable because there are available treatment technologies and existing drinking water supply lines. However, the high concentrations of COCs that exist in OU2 would require significant treatment and monitoring requirements, resulting in high cost of treatment to drinking water standards.

Water rights are needed to implement this end use option and can be obtained as follows:

- Buying or leasing water rights from a water rights holder
- Developing an agreement with a water purveyor who has available water rights and is willing to accept treated water using their water rights; or developing agreements with multiple purveyors if a single purveyor does not have sufficient water rights

In addition to water rights, a replenishment assessment, currently at \$205 per acre-foot for fiscal year 2010 to 2011, would be assessed because the water is used beneficially.

For purposes of this FS, it has been assumed that an agreement with one or more purveyors with sufficient water rights can be developed, as noted previously, for the portion of water that is used as drinking water. Buying or leasing water rights could be evaluated during RD as well. In addition, for purposes of this FS, it is assumed that negotiations with the water purveyor receiving the potable water would result in the water recipient paying the replenishment assessment as they normally would. This option is retained for further analysis.

The drinking water treatment process will generate a waste brine stream high in TDS, which cannot be reused and will be discharged to a sewer. An NWU Permit and replenishment assessment exemption can be obtained, at WRD's discretion, for the volume of water extracted that ends up as non-reusable waste brine.

### **Reclaimed Water**

This option has low implementability, high effectiveness, and high cost. The treated water would be used for beneficial purposes. Several reclaimed water lines already exist in the OU2 area, making the construction of this option highly implementable. The lines are close to the potential treatment locations, which helps with implementation and also helps lower the relative cost of this potential end use. The demand for reclaimed water may vary throughout the year, which may necessitate periodic system shutdowns or coupling with another end use; the low demand makes the implementability of this end use low.

Water rights would have to be obtained by leasing, buying, or negotiating use of water rights as discussed for the drinking water alternative. A replenishment assessment fee would be assessed because the water is being used beneficially. For purposes of this FS, it is assumed that the entity implementing the remedy would incur the full expense of the replenishment assessment. This is a reasonable assumption based on the current situation of oversupply of reclaimed water in which it is unlikely that the reclaimed water recipient would pay the replenishment assessment.

The reclaimed water treatment process will generate a waste brine stream high in TDS, which cannot be reused and will be discharge to a sewer. An NWU Permit and replenishment assessment exemption can be obtained, at WRD's discretion, for the volume of water extracted that ends up as non-reusable waste brine.

### **Reinjection**

Reinjection to the deep zone has moderate implementability, high effectiveness, and high cost. There is practically unlimited reinjection potential (continuous injection at high-flow rates), however, the need for extensive permitting and agency approvals would result in moderate implementability. Stringent discharge requirements will necessitate the partial removal of TDS by RO, and the removal of any contaminants that are not present at lower levels in the existing deep aquifer. The drinking water aquifers in the Central Basin have an average TDS of 500 mg/L (WRD, 2008; Reichard et al., 2003), but TDS is higher in the shallow groundwater in the OU2 area, measuring in the 430- to 5,900-mg/L range (CH2M HILL, 2010). According to the Los Angeles County Basin Plan (RWQCB, 1994), the water quality objective for TDS for the Los Angeles Coastal Plain Central Basin is 700 mg/L.

Deep injection wells could be installed near the treatment plants, which would eliminate the need for lengthy pipeline construction and thereby lower overall costs. Nonetheless, the cost for installation and operation of deep reinjection wells is high. Reinjection returns the treated water to the deep aquifer at OU2 and preserves groundwater as a resource.

Water rights can be addressed by applying for and obtaining an NWU Permit for the entire extracted volume because the use is not consumptive. A replenishment assessment exemption could be obtained because the extracted water is returned to the groundwater at equal or better quality. The replenishment assessment exemption would also be applicable for the high-TDS waste brine that is generated during the treatment process and which would be sent to the sewer.

### **Spreading Basin Infiltration**

This option has moderate implementability, effectiveness, and cost. The recharge basins already exist and are located in the vicinity of and northwest of OU2; however, approvals from multiple cognizant agencies would be required. This option would require piping from the extraction wells to the basins, which would increase the cost. The recharge basins may shut down for up to 1 month per year for maintenance purposes, which would require temporary extraction shutdowns or coupling with another end use.

Water rights would be addressed in the same way as for the reinjection end use alternative described previously because the extracted water would be put back into the aquifer in the basin at the same or better quality. An NWU Permit is required and a replenishment assessment exemption could be obtained to implement this end use option. The replenishment assessment exemption would also be applicable for the high-TDS waste brine that is generated during the treatment process and which would be sent to the sewer.

## **3.2.4 Treatment Options**

This section qualitatively evaluates and screens the treatment options for the extracted groundwater.

### **3.2.4.1 Description**

Treatment options are summarized in Table 2-3. The treatment options are driven by the COCs listed in Table 2-1 and the end use of the treated water. The various treatment technologies potentially applicable for specific COCs are discussed in the following pages. The treatment requirements driven by the end use options are based mainly on the current groundwater quality at OU2. The actual influent concentrations will, over the long term, depend to a large degree on the source control measures adopted at the state-led facilities that contribute to groundwater contamination at OU2, particularly for contaminants such as Cr+6 and 1,4-dioxane.

#### **1,4-Dioxane**

1,4-Dioxane concentrations will need to be reduced for the retained end use options. Typically, this COC is removed using an AOP as described in Section 2.

#### **Total Chromium and Cr+6**

Total chromium and Cr+6 concentrations may need to be reduced for the retained end use options. This COC can be effectively removed by a variety of technologies, including IX

process, membrane processes such as NF and RO, ferrous iron reduction and filtration, and biological treatment. Ferrous iron reduction and biological treatment are relatively complicated treatment processes compared to IX. In general, IX is cost effective when the water to be treated has relatively low concentrations of IX competing ions such as nitrates.

### General Metals

Some general metals, including aluminum and manganese, may need to be removed, depending on the discharge or reuse option selected. These can be readily removed, using conventional metals precipitation processes based on the addition of lime or caustic to precipitate out the metals. The precipitated solids can be removed by media filtration or conventional gravity separation using thickener/clarifiers to produce a thicker slurry of precipitated solids. The resulting settled solids would be dewatered in a filter press and disposed of offsite. Metals can also be removed using IX and NF or RO membrane processes.

### VOCs and SVOCs

VOCs and SVOCs can be treated using a variety of technologies, such as oxidation, adsorption, air stripping, and biological degradation. In general, oxidation processes and biological processes are generally more complicated and expensive for general VOC and SVOC treatment compared to more conventional adsorption and air stripping processes. However, oxidation processes such as AOP, when used specifically to treat other targeted constituents such as 1,4-dioxane or NDMA, for example, will also oxidize a wide range of VOCs and SVOCs in the same process. This provides an overall beneficial result if these VOCs and SVOCs need to also be removed from the groundwater. Unfortunately, certain types of VOCs, such as alkanes, are often only partially oxidized by AOP processes and can create hard-to-treat recalcitrant VOC byproducts. In these situations, a biological process is well suited to address these potential AOP byproduct VOCs. A conventional LGAC process is often used after a Bio-LGAC process.

Treatment for VOCs is typically done using conventional LGAC or air stripping instead of more complicated and more expensive chemical oxidation or biological systems. Air stripping is typically more cost-effective when VOC levels are relatively high (greater than 70 parts per billion [ppb]), while LGAC is typically more cost-effective when VOC concentration levels are relatively low (less than 70 ppb). Variations exist depending on the specific COCs involved.

### Selenium

Selenium can be removed using technologies such as RO, anoxic biological treatment, IX, and wetlands treatment. Selenium removal is currently being studied by a number of regional and statewide working groups to find practical methods for removal of selenium to meet a surface water discharge limit of 5 ppb.

### Perchlorate

Perchlorate can be effectively removed using IX or FBRs. In general, the FBR process is more cost-effective than IX when perchlorate concentrations are high and the concentration of IX resin competing ions, such as nitrate, are high.

## TDS

TDS and associated constituents such as sulfate and others can be effectively removed by membrane processes such as NF and RO. The membrane technology most applicable depends on specific treatment requirements. NF operates at relatively low pressures compared to RO. NF is very effective in removing divalent ions of all types, such as nitrate and sulfate. It is not as effective for monovalent ions such as sodium or chloride. RO is generally more effective than NF in that it removes a wider range of constituents from water.

### 3.2.4.2 Evaluation

#### 1,4-Dioxane

AOP technology will be retained for removal of 1,4-dioxane for the various end use options. AOPs typically involve ozone plus hydrogen peroxide or UV light plus hydrogen peroxide. The ozone-based process has the advantage of being able to handle water that is turbid or not clear, whereas the UV-based process cannot handle high-turbidity water because it impedes the action of the UV light energy. In contrast, the UV-based systems are commonly used in drinking water applications. For purposes of this FS, an AOP based on UV light plus hydrogen peroxide oxidation is assumed as a representative process for development of remedial alternatives. During the future remedial design phase, other AOP technologies (with similar effectiveness, implementability, and cost) based on ozone plus hydrogen peroxide should be considered and evaluated as well. The use of any AOP for removal of 1,4-dioxane provides another benefit in that appreciable amounts of alkene-type VOCs, and to a lesser extent, alkane-type VOCs, are also destroyed in the process.

#### Cr+6

IX technology will be retained for removal/reduction of Cr+6 as appropriate in the various end use options. In general, IX is very cost-effective when the water to be treated has relatively low concentrations of IX competing ions (i.e., nitrates). In OU2, the extracted water is expected to have relatively low nitrate as well as Cr+6 concentrations. Consequently, IX is selected as the representative treatment technology, if needed for removal of Cr+6.

#### VOC and SVOC

A Bio-LGAC process, rather than a more complex FBR process, will be considered for use as a representative technology for treating AOP-generated VOC byproducts in the various remedial alternatives to be developed.

Conventional LGAC will be used as representative technology for development of remedial alternatives over air stripping, as appropriate, for residual VOC removal after upstream VOC removal by AOP and Bio-LGAC treatment. During the remedial design phase, VOC removal technologies, including LGAC and air stripping, should be more rigorously evaluated to select the optimal treatment process.

## TDS

NF can be cost-effective when gross TDS removal is required. RO is the practical choice for treatment when a high level of TDS removal is required and all constituents must be reduced to low concentration levels. Both NF and RO technologies are retained for use in

development of remedial alternatives, as appropriate, for end uses that require different levels of TDS or specific COC removal.

### 3.2.5 Number of Treatment Plants and Locations

#### 3.2.5.1 Description

Although not a remedial technology or process option, the number and location of groundwater treatment plants (GWTPs) to be considered in the development of remedial alternatives need to be addressed. Three potential locations for treatment facilities were identified for this FS. These locations are identified in Figure 3-1 and are further described as follows:

- Empty lot approximately 1,000 feet east of MW30 (near LE)
- Empty lot on the northwest corner near the former Oil Field Reclamation Project (OFRP) area (near CE)
- Empty lot rail yard between MW23 and MW25 (near NE)

Based on previous discussions, groundwater may be extracted in selected areas of the plume identified as LE, CE, and NE. Accordingly, either a single large centralized treatment plant to treat the entire OU2 extracted groundwater or smaller GWTPs could be located near each extraction area. Other factors that may affect the number and location of GWTPs include conveyance pipeline distances between extraction wells and the GWTP, and conveyance distances between the GWTP(s) and potential end use locations. To reduce the number of possible permutations and combinations of the number (and capacity) of GWTPs and their locations, a simple cost evaluation was done to determine a representative number and size of GWTP(s) to be used in developing remedial alternatives. This approach would allow development of a more manageable number of remedial alternatives.

#### 3.2.5.2 Evaluation

A simplified cost evaluation of the cost impact of a single large GWTP compared to two or three smaller GWTPs was performed and is summarized in the following table. In this evaluation, a nominal treatment capacity of 2,000 gpm was assumed. A representative treatment process comprised of AOP for 1,4-dioxane removal, LGAC for VOC removal, and an RO process for reduction of TDS was also assumed. In addition, only pipelines for conveyance of extracted water to the treatment plants were considered. Cost for conveyance of treated water to potential end use locations was excluded for purposes of this brief evaluation.

Description of GWTP and Capacities	Approx. Capital Cost
1–2,000-gpm centralized GWTP at CE	\$29,000,000
1–1,000-gpm GWTP at LE + 1–1,000 gpm GWTP at CE	\$36,000,000
1–1,000-gpm GWTP at LE + 1–500 gpm GWTP at CE + 1–500 gpm GWTP at NE	\$41,000,000

As indicate in the previous table, the cost of two or three smaller GWTPs is higher compared to a single large GWTP. The lower costs of shorter conveyance pipeline lengths associated with multiple smaller GWTPs do not offset the combined higher costs of the smaller GWTPs.

For purposes of this FS, a single GWTP plant is assumed for development of remedial alternatives. The location of the GWTP will depend on the extraction scenario and end use option used for each remedial alternative. During the future remedial design phase of the project, a more refined and detailed evaluation of the number and size of GWTPs and associated conveyance pipelines will be conducted to identify an optimum configuration.

### 3.3 Development of Remedial Alternatives for Detailed Evaluation

This section describes the rationale for combining technologies into alternatives, including the following:

- The technologies and process options that were screened and retained for alternatives development in Section 2 are assembled into a range of alternatives in this section using representative technologies and process options. During the RD phase, all the technologies and process options that were retained in Section 2 should be re-evaluated to identify the optimal combination for implementation of the selected remedy.
- The containment options were reduced to two extraction scenarios—one with pumping at LE only and the second with pumping at all three locations (LE, CE, and NE). The LE only extraction was included for the evaluation of a limited extraction scenario; although this scenario could be implemented with any of the end use options, only the drinking water end use was used in the alternative.
- The end use options include drinking water, reclaimed water, discharge to spreading basins, and deep aquifer reinjection.
- The treatment technologies and system locations for the four end use options and two extraction options differ. Some of the treatment technologies are interchangeable, with similar effectiveness and cost; for such cases, a representative technology is selected for detailed alternative evaluation. The actual combination of treatment technologies may be modified during the RD. For example, either IX or membrane technologies (RO or NF) are suitable for Cr+6 removal. Furthermore, IX was used in some of the alternatives to remove Cr+6 upstream in the process, such that a smaller RO process could be used just to meet TDS limits. There are other combinations of technologies that should be evaluated in the RD.

The selection of alternatives for detailed evaluation is driven by the end use.

#### 3.3.1 Alternative 1—No-Action

EPA guidance (EPA, 1988) requires that a No-Action Alternative be considered and compared to the action alternatives. The No-Action Alternative is therefore included as a

baseline alternative and does not include active remediation or monitoring at OU2. No cost is associated with this alternative.

This alternative recognizes the existing and planned/approved facility-specific actions, any existing regulatory and statutory controls over groundwater extraction and use, any existing or planned non-CERCLA response activities (such as cleanup under state orders or wellhead treatment systems installed by operators at production wells affected by VOCs), and natural attenuation. For example, the interim groundwater system at Omega OU1 has been built and is operational. The system captures and treats contaminated groundwater immediately downgradient of the former Omega facility and is intended to prevent the contaminant mass in OU1 groundwater from migrating into OU2. In addition, source control measures may be implemented in the future at some or all of the other approximately 20 sources of contamination at OU2. It is expected that such contamination source control measures will reduce contaminant concentrations in the source zones and will minimize or prevent continual feeding of contaminants into the OU2 aquifer. However, it is expected that containment of the OU2 plume will not be an objective of these source control measures.

### 3.3.2 Alternative 2—Leading Edge Extraction with Drinking Water End Use

#### 3.3.2.1 Overview of Alternative 2

Alternative 2 consists of groundwater extraction at the LE of OU2 to prevent further migration of contaminated groundwater into the downgradient areas. Extracted groundwater will be treated at a centralized treatment plant. The treated water will be distributed to a municipal water supply system as drinking water. Drinking water end use was selected as a representative end use option because water extracted at LE would be less contaminated and relatively easier to treat to drinking water standards compared to water extracted from CE and NE. The drinking water end use under this alternative would be consistent with regional efforts to reduce the amount of potable water that is imported into Southern California. Groundwater monitoring is needed under this alternative to measure the system performance and to provide early warning of upgradient changing conditions that could adversely affect system performance. The general locations of extraction wells, conveyance pipelines, and the treatment plant are shown in Figure 3-3. Institutional controls would include notifications and coordination discussed in Section 3.2.1.

#### 3.3.2.2 Extraction Wells, Conveyance Pipelines, and Monitoring Wells

The extraction system consists of three extraction wells located at the LE of the OU2 plume, with each well having an extraction rate of approximately 600 gpm. To keep the numerical model simple, a minimum possible number of extraction wells were used to simulate capture under each alternative. Two wells were sufficient for simulating the plume capture in the model under this alternative. The model predicts that the wells capture the plume both laterally and vertically; however, the actual system may not reliably achieve vertical capture throughout the entire plume due to strong vertical gradients and heterogeneities in the aquifer. Actual implementation of the remedy would require more wells; for costing purposes, three wells were assumed under this alternative. The assumed locations for LE extraction are shown in Figure 3-3. The exact locations for the extraction wells are subject to practical limitations such as access. The extraction well pumps would each be equipped

with a variable frequency drive (VFD) to allow for adjustment of pumping rate to maintain containment as may be required.

Conveyance pipelines will be provided as indicated in Figure 3-3. The extracted groundwater pipelines are relatively short because the centralized GWTP would be in the vicinity of the extraction wells. However, the longest pipeline segment is associated with the treated potable water line from the GWTP to an existing 4-million-gallon (MG) water tank owned and operated by the City of Santa Fe Springs, located near the intersection of Florence Avenue and Bloomfield Avenue. An equally long pipeline would be needed to convey waste reject brine from a membrane filtration process at the GWTP to an industrial sewer trunk line near the same intersection noted previously. The major features of these pipelines are summarized in Table 3-1.

Groundwater monitoring under this alternative would fulfill the following two main objectives: (1) provide information to monitor the effectiveness of the containment system and optimize the system performance and (2) provide early warnings of upgradient changing conditions that could adversely affect system performance or necessitate system modifications, such as a change in groundwater flow conditions, a change in contaminant concentrations, and detection of new contaminants.

It is assumed that the existing groundwater monitoring network at Omega (i.e., OU2 Wells MW1 to MW31 and OU1 and OU2 Wells OW1 to OW9) is sufficient to fulfill the second monitoring objective. However, additional monitoring wells complementing the current monitoring network are needed downgradient of the LE extraction wells to fulfill the first monitoring objective. For cost estimation, this alternative assumes that additional monitoring wells will be installed at six locations downgradient of the extraction wells and a cluster of four monitoring wells will be installed at different depths at each location, for a total of 24 new monitoring wells. The specific locations of these monitoring wells will be determined during the RD phase.

For the purpose of estimating costs, it was assumed that the new monitoring wells would generally be monitored on a quarterly basis for the first 2 years and the monitoring frequency could be reduced to semiannually thereafter. The existing groundwater monitoring network wells at OU2 would also likely require monitoring on a similar frequency, depending on the CDPH 97-005 permit requirements. In some cases, the CDPH 97-005 permit requirements may require more frequent sampling initially, perhaps on a monthly basis for a period of time, before the sampling frequency is reduced to a quarterly basis. In addition, the CDPH 97-005 permit may also require monitoring in areas outside but in the vicinity of OU2 to provide additional early warning of potential water quality changes.

### 3.3.2.3 Treatment Plant Influent Concentration and Discharge Limits

Extraction at the LE will eventually draw in more contaminated groundwater from upgradient areas, as well as groundwater relatively low in contaminant concentrations in the vicinity of the extraction area over time. Consequently, it is difficult to estimate expected contaminant concentrations in the extracted groundwater. For purposes of this FS, however, the following simplifying assumptions are made with regard to estimating representative design influent COC concentrations into the treatment plant:

- MW26B water quality is used as a representative extracted water surrogate for purposes of defining the treatment plant influent concentration basis of design because it is expected that COCs at concentrations near MW26B will eventually arrive at the LE wells. However, design influent concentrations will be addressed in the following two time periods:
  - **Initial GWTP** will be designed to handle up to the equivalent of one-half of the COC concentrations found in neighboring Well MW26B for the first 15 years of operation of the overall 30-year remedy operation used as a basis for the cost estimate.
  - **Supplemental GWTP** will be designed to handle the COC concentrations in MW26B for the final 15 years of operation of the overall 30-year remedy operation.

During the remedial design phase, a more rigorous approach for estimating treatment plant design influent concentrations should be used based on more complete groundwater sampling data available at that time.

Two 15-year time periods were assumed because of the uncertainty involved in estimating a suitable basis of design for this alternative. The initial design and treatment plant installation is based on providing suitable treatment for the first 15 years of operation of diluted groundwater. This diluted groundwater is characterized by contamination that may increase to those levels approximated as up to one-half of the current concentrations at upstream Monitoring Well MW26B. For purposes of this FS, a supplemental treatment facility is assumed to be required at the end of the initial 15-year operational period to be able to treat groundwater that may have contaminant concentrations approaching those similar to what is currently found in MW26B. This supplemental treatment plant may not be needed (it will depend on future GWTP influent concentrations) but is included in this alternative as a potential future need with its associated costs.

COC concentrations exceeding drinking water standards based on both one-half the concentrations and 100 percent of the concentrations in MW26B water are summarized in Table 3-2. These concentrations will be the influent design basis for the initial plant design and for the assumed supplemental treatment plant for the last 15 years of project life operation.

#### 3.3.2.4 Treatment Plant Process

Based on the concentration information and drinking water limits shown in Table 3-2, all of the COCs listed in the table (except total chromium) must be treated during the first 15 years of operation to reduce effluent concentrations to below target levels. During the second 15 years of operation, treatment will be needed for all of the COCs listed in Table 3-2 to achieve effluent concentrations that are below drinking water standards.

The proposed treatment process is summarized in Figure 3-2 and includes the following key process steps:

- AOP for 1,4-dioxane removal using UV light and hydrogen peroxide; some VOCs removed; some partial oxidation byproducts potentially formed
- Bag filters for removal of precipitates (iron [Fe], manganese [Mn]) potentially formed in AOP

- Bio-LGAC for removal of potential recalcitrant partial oxidation products formed in AOP
- LGAC for removal of residual VOCs
- NF for removal of total (and hexavalent) chromium/TDS/sulfate (SO<sub>4</sub>)
- Disinfection using chlorination to meet potable water standards
- Discharge of treated water (NF permeate) to existing water storage tank for blending with City of Santa Fe Springs drinking water
- Discharge of NF reject brine to industrial sewer trunk line near intersection of Bloomfield Avenue and Florence Avenue

The treatment plant design flow capacity is 1,800 gpm while the average flow rate would be about 1,200 gpm.

The Bio-LGAC and LGAC were placed after AOP in Alternatives 2 through 6 because AOP generates partial oxidation byproducts and generally needs LGAC polishing. However, other configurations such as having the LGAC process ahead of the AOP unit followed by Bio-LGAC should be evaluated in the RD as part of system optimization.

#### 3.3.2.5 Initial Installation for First 15 Years of Operation

Extracted groundwater is initially pumped to an onsite storage tank to provide surge capacity. The water is pumped through bag filters for removal of any particulates down to about 10 microns in size prior to treatment. The assumed AOP is based on UV light plus hydrogen peroxide for oxidation of 1,4-dioxane. Hydrogen peroxide is injected into the feed stream to the AOP treatment module at about 25 ppm. The design power requirement for the UV lights is about 14 kilowatts (kW) while the average usage is about 9 kW. Although the drinking water notification level for 1,3 dioxane is 3 ppb, the AOP module is designed to reduce 1,4-dioxane from about 4 ppb to 2 ppb for design safety factor purposes.

AOP also significantly reduces VOCs. Alkene-type VOCs can be reduced by about 50 percent while alkane-type VOCs can be reduced in the range of 5 to 10 percent based on the UV light power levels noted previously. These VOC reductions reduce the contaminant load on the downstream LGAC system.

AOP will also remove iron and manganese by oxidizing them in the form of a precipitate. This precipitate can foul UV lamps within the AOP module. AOPs can be provided with automatic UV lamp cleaning mechanisms to mitigate this problem. During the future remedial design phase, alternative ways of dealing with potential precipitate fouling of the AOP module should be considered, such as an upstream greensand filter or use of an ozone/hydrogen peroxide AOP that would not be prone to fouling the UV lamps. For purposes of this FS, the AOP effluent is pumped through bag filters to remove any precipitates that may be formed. The bag filters will require periodic replacement. In addition, particulates will also be removed by the downstream Bio-LGAC process.

AOPs often produce some partial oxidation byproducts that are not easily amenable to downstream conventional LGAC treatment. Accordingly, a Bio-LGAC treatment step is provided to remove these recalcitrant type organic constituents. The recalcitrant organic

compounds are removed by a biological film that grows on the surface of the GAC particles. The biological process creates a biomass that is periodically removed by backwashing and air scouring carbon beds, after which the carbon beds are placed back in service. This backwashing process will also remove any AOP-generated particulates not removed by the upstream bag filters along with the accumulated biomass.

Prior to Bio-LGAC, sodium metabisulfate is injected into the AOP effluent to remove any residual hydrogen peroxide from the AOP process. Residual hydrogen peroxide is a strong oxidant and must be removed so that beneficial bacteria in the Bio-LGAC process are not destroyed.

Four Bio-LGAC beds (three operating plus one spare) are provided in a parallel configuration. Each standard LGAC vessel is approximately 10 feet in diameter and contains about 20,000 pounds of GAC. They would be operated in parallel and would be sequentially backwashed and air scoured on an as-needed basis. Backwash water is sent to an approximately 20,000-gallon sloped or coned bottom backwash tank in which the solids are allowed to settle. After accumulation of solids sludge, the solids are pumped through a plate and frame type filter press to about 20 to 40 percent solids content and then sent offsite for disposal at a landfill or other facility. Capability to add a polymer to the backwash contents is provided to enhance liquids-solids separation in the backwash tank. The water remaining in the backwash tank is decanted and recycled back to the front end of the process. Backwash water for the Bio-LGAC vessels is supplied from the treated water tank at the end of the process.

The Bio-LGAC effluent is further treated in a conventional LGAC process for removal of remaining VOCs. Four parallel trains (three operating plus one spare) of two LGAC vessels per train (in lead/lag configuration), with each vessel approximately 10 feet in diameter and containing about 20,000 pounds of GAC, are provided. Because of the relatively low level of VOC concentrations in the LGAC influent after upstream AOP treatment, conventional LGAC treatment for removal of residual VOCs was assumed for the treatment process over air stripping. In general, LGAC is more economical in treating lower concentrations of VOCs. During the remedial design phase, both air stripping and LGAC VOC treatment processes should be evaluated in more detail to determine the most appropriate treatment process. The cost and performance of both systems would be expected to be similar.

When the LGAC becomes saturated with VOCs, the carbon must be replaced. Based on the average operating conditions assumed to be represented by one-half of MW26B concentrations, the LGAC would last about 90 days between carbon change outs. This preliminary carbon usage estimate is based on LGAC process simulation/modeling used to identify the controlling COC. For the OU2 COC mix, 1,2-DCA is the controlling contaminant for carbon usage estimating purposes.

If required, the LGAC can be periodically backwashed with water from the treated water tank. The backwash water is handled in the same manner as that described for Bio-LGAC backwashing, except the amount of solids in the backwash water will be much less compared to Bio-LGAC backwash water.

To meet drinking water standards, both Cr+6 and TDS concentrations must be reduced. TDS and sulfate (which is a constituent of TDS) must be reduced from levels of about

1,100 mg/L and 320 mg/L, respectively, to less than 500 mg/L and 250 mg/L, respectively. Total chromium does not need to be reduced during the initial 15-year operating period but may require reduction during the second 15-year operating period as discussed below.

NF is proposed to reduce TDS and  $\text{SO}_4$ . Reduction of TDS levels will reduce  $\text{SO}_4$  levels commensurately because  $\text{SO}_4$  is a constituent of TDS. To prevent biofouling of the NF membranes by microorganisms in the Bio-LGAC effluent, the NF feedwater is disinfected with an NSF International (NSF) grade biocide. The biocide is injected into the water using an in-line mixer and fed to an 18,000-gallon NF feed tank.

The NF system is composed of two 50 percent capacity trains operating in parallel to provide a greater degree of flexibility. The NF system is a complete, skid-mounted system and includes all provisions for feed and effluent pH adjustment, antiscalent chemical injection, and clean-in-place (CIP) systems for proper operation and maintenance of the NF system.

The NF system has an overall recovery of about 75 percent and corresponding waste reject stream of about 25 percent of the total feed to NF. Over half of the TDS will be concentrated in the brine reject stream, which will be pumped to an industrial sewer trunk line located near the intersection of Bloomfield Avenue and Florence Avenue. This sewer trunk line discharges to the Joint Water Pollution Control Plant in Carson for eventual discharge to the Pacific Ocean after standard POTW treatment. Currently, there are no limits on Cr+6 or TDS for this discharge. The POTW has the permits for ocean discharge; the remedy would only have to comply with the POTW water quality requirements, which reflect any ocean discharge requirements in their permit.

A conventional NF recovery rate of 75 percent was assumed for this alternative. The NF recovery rate can be increased by adding additional NF stages, at additional cost. During the future remedial design phase, a more rigorous analysis should be done to identify and analyze the cost of an NF system that provides an optimum NF recovery rate. In addition, a more detailed analysis and membrane system modeling should be done to confirm pretreatment requirements to deal with potential membrane fouling problems.

Recovered water from the NF system is disinfected to potable standards using direct in-line injection of sodium hypochlorite. A 30,000-gallon storage tank is provided for surge capacity and to provide a source of clean water for backwashing Bio-LGAC, LGAC, and for cleaning the NF system. These backwashing details are not shown on the simplified process flow diagram.

The disinfected, potable-grade water is subsequently pumped to an existing 4-MG potable water storage tank owned by the City of Santa Fe Springs and located near the intersection of Bloomfield Avenue and Florence Avenue, for blending with the City's drinking water.

Overall, the GWTP has a design capacity to produce about 1,350 gpm of potable water with an average production of about 900 gpm. The treatment plant will produce about 450 gpm of waste brine at design capacity rates, with an average rate of about 300 gpm. Although a significant amount of waste brine is generated from the GWTP, the volume of waste brine generated can be possibly reduced during the remedial design phase by performing an NF recovery optimization study as discussed previously.

### 3.3.2.6 Supplemental Installation for Subsequent 15 Years of Operation

For purposes of this FS, it is assumed that the treatment plant will have to treat groundwater concentrations that will be approaching 100 percent of COC concentrations in MW26B during the sixteenth through thirtieth year of the remedy, as shown in Table 3-2. Based on this assumption, all the other COCs will double in concentration except for sulfate and TDS. The initial GWTP can effectively treat the higher levels of all COCs anticipated except for 1,4-dioxane.

A supplemental AOP process would be required to address the potentially increasing 1,4-dioxane. The AOP process, whose size and treatment capacity is based on hydraulic flow and the log concentration removal factor, which is defined as  $\text{Log}(\text{inlet 1,4-dioxane}/\text{outlet 1,4-dioxane concentration})$ , would be increased. Based on the same design flow rate of 1,800 gpm, the log removal ratio of 0.23 at initial groundwater concentrations would need to be increased to a log removal ratio of about 0.50, or an increase of about 120 percent. To provide this additional level of treatment, a second AOP module of approximately the same size as the initial module would be installed in series with the first AOP installation. Total design power requirement for the UV lights is about 29 kW combined for both the initial and supplemental AOP process.

The other treatment processes would be affected to a lesser extent in that only operating conditions would change and frequencies of Bio-LGAC and LGAC backwashing or carbon replacement would increase. There would be little impact on the performance or effectiveness of the NF system. It would continue to reduce TDS (including sulfate) to target levels. In addition, NF would reduce total influent chromium concentrations at about 52 ppb to below the 50 ppb MCL.

The need for a supplemental AOP process should be evaluated more thoroughly in the RD phase, using additional groundwater water quality data and more refined groundwater modeling. The option of initially installing a suitably larger AOP process should also be considered.

The assessment of the environmental footprint of this alternative (both the initial 15-year and second 15-year operational periods) is preliminary during the FS review of remedial alternatives. The environmental footprint of this alternative will be revisited at the RD phase and green remediation principles will be integrated into the design and operation of the groundwater extraction and treatment system. During the RD phase, the environmental footprint of the remedy will be reduced to the maximum extent practicable to ensure that protection of human health and the environment occurs. Detailed engineering studies will be conducted to optimize pipeline routing and design, for example, not just to reduce the initial cost of pipeline installation, but to account for energy usage (pumping power costs) associated with different pipeline materials (e.g., use smaller versus larger pipe sizes; use of smoother pipeline materials to reduce pressure losses, etc.). The design will include consideration of extensive use of lower energy consuming equipment such as variable frequency motors with high efficiencies as well as solar panels to produce onsite power to offset facility power requirements from the local power supplier. In addition, consideration will be given to procurement of electrical power from greener source suppliers. Emerging technologies and changes in the economic environment at the time of remedial design effort will also be considered to minimize the environmental footprint of the selected remedy.

### 3.3.3 Alternative 3—Plumewide Extraction with Reclaimed Water End Use

#### 3.3.3.1 Overview of Alternative 3

Alternative 3 consists of groundwater extraction at three locations, treatment at a central facility and discharge of treated water to a reclaimed water line. In addition to extracting groundwater at the leading edge of the OU2 plume to prevent further migration of contaminated groundwater into the downgradient areas, extraction of highly contaminated groundwater at two locations downgradient of the two zones of high VOC concentrations would be used to more effectively contain or remove groundwater contamination. The two extraction locations are referred to as the NE and CE areas. Extracted groundwater will be treated with a centralized GWTP located in the vicinity of the CE extraction area. The treated water will be discharged to the reclaimed water line. The reclaimed water end use under this alternative would be consistent with water conservation efforts in the Central Basin. Groundwater monitoring is needed under this alternative to measure the system performance and to provide early warning of upgradient changing conditions that could adversely affect system performance. The locations of extraction wells, conveyance pipelines, and the treatment plant are shown in Figure 3-5.

ICs would include notifications and coordination discussed in Section 3.2.1.

#### 3.3.3.2 Extraction Wells, Conveyance Pipelines, and Monitoring Wells

The extraction system under this alternative assumes two CE wells with an extraction rate of approximately 250 gpm each, two NE wells with an extraction rate of approximately 250 gpm each, and three LE wells (represented by two wells in the numerical model) with an extraction rate of approximately 350 gpm each; the total extraction rate is 2,050 gpm (nominally 2,000 gpm) for the plumewide extraction. The exact locations for the extraction wells will be determined during the remedial design and would depend on future land uses and practical limitations such as access. The extraction well pumps would each be equipped with a VFD to allow for adjustment of pumping rate in response to changes needed to maintain containment.

Conveyance pipelines will be provided as shown in Figure 3-5. Relatively long pipelines will be needed to convey groundwater from the LE and NE extraction areas to the centralized GWTP, whereas a relatively short pipeline from the CE extraction wells to the centralized GWTP will be needed. In addition, a pipeline will be needed to convey treated reclaimed water to an existing reclaimed water trunk line for distribution. The line, owned and operated by CBMWD, is near the intersection of Norwalk Boulevard and Florence Avenue. Similarly, a pipeline is needed to convey waste reject brine from a membrane treatment process at the GWTP to an industrial sewer trunk line near the same intersection noted previously. The major features of these pipelines are summarized in Table 3-1.

Groundwater monitoring under this alternative is also needed to (1) provide information to monitor the effectiveness of the containment system and to optimize the system performance and (2) provide early warning of upgradient changing conditions that could adversely affect system performance or necessitate system modifications, such as a change in groundwater flow conditions, a change in contaminant concentrations, or detection of new contaminants.

It is assumed that the existing groundwater monitoring network at Omega OU2 is sufficient to fulfill the second monitoring objective. However, additional monitoring wells complementing the current monitoring network are needed downgradient of the LE extraction wells to fulfill the first monitoring objective. For cost estimation, this alternative assumes that a total of 10 clusters of wells will be installed at locations downgradient of the LE, CE, and NE wells, with each well cluster assuming four wells installed at different depths within the contaminated aquifer.

For the purpose of estimating costs, it was assumed that the monitoring wells would generally be monitored on a quarterly basis for the first 2 years and the monitoring frequency could be reduced to semiannually thereafter.

### 3.3.3.3 Treatment Plant Influent Concentration and Discharge Limits

Plumewide extraction at LE, CE, and NE will result in a blend of groundwater with varying general water quality and COC concentrations. For purposes of this FS, the following simplifying assumptions are made with regard to estimating representative design influent COC concentrations into the treatment plant:

- LE Flow Contribution – 50 percent of total flow using MW27A and MW27B concentrations as representative of LE extracted groundwater; furthermore, highest values of COCs detected between these two wells are used to approximate LE water quality
- CE Flow Contribution – 25 percent of total flow using MW26B COC concentrations as representative of CE extracted groundwater
- NE Flow Contribution – 25 percent of total flow using MW23A and MW23C concentrations as representative of NE extracted groundwater

During the remedial design phase, a more rigorous approach for estimating treatment plant design influent concentrations should be used based on more complete groundwater sampling data.

A summary of the anticipated COC concentrations of the extracted and blended groundwater influent to the GWTP is presented in Table 3-3. The reclaimed water discharge standards are also shown for reference.

### 3.3.3.4 Treatment Plant Process

The concentrations of COCs listed in Table 3-3 must be reduced to the reclaimed water standards listed in the table. In general, discharge standards are similar to surface water discharge standards because reclaimed water used for irrigation purposes can end up as irrigation runoff that is diverted to surface waters in the area. The proposed treatment process is summarized in Figure 3-4 and includes the following key process steps:

- Cr+6 removal using IX with pH adjustment before and after IX
- AOP for 1,4-dioxane removal using UV light and hydrogen peroxide; some VOCs removed; some partial oxidation by-products potentially formed
- Bag filters for removal of precipitates (Fe, Mn) potentially formed in AOP

- Bio-LGAC for removal of potential recalcitrant partial oxidation products formed in AOP
- LGAC for removal of residual VOCs
- RO treatment of about 50 percent of the flow stream for reduction of selenium, TDS, and  $\text{SO}_4$
- Blending of RO treated RO bypass water to meet selenium, Cr+6 /TDS/ $\text{SO}_4$  discharge limits
- Discharge of blended treated water to the reclaimed water trunk line near the intersection of Norwalk Boulevard and Florence Avenue
- Discharge of RO reject brine to the industrial sewer trunk line near intersection of Norwalk Boulevard and Florence Avenue

The treatment plant design flow capacity is nominally 2,000 gpm while the average flow rate is about 1,300 gpm. The hydraulic capacity of the treatment plant is about 10 percent larger than the 1,800 gpm GWTP in Alternative 2.

In the process, extracted groundwater is pumped to an onsite storage tank to provide surge capacity. The water is pumped through bag filters for removal of any particulates down to about 10 microns in size prior to treatment in the AOP unit.

Cr+6 is first removed from the water by treatment with weak base anion resin in an IX system. The pH is first reduced to about pH 6 using sulfuric acid to allow the weak base anion resin to work effectively. The IX system is composed of four parallel pairs of lead/lag IX vessels. A total of eight vessels is provided, each about 12 feet in diameter and containing about 350 cubic feet of resin. The resin is expected to last approximate 540 days, after which the resin would be replaced. Periodically, the IX beds would be backwashed to remove the buildup of dirt and silt to maintain acceptable pressure drop levels across the IX resin beds. Backwash water would be routed to a common backwash tank that is also used for backwashing the Bio-LGAC vessels and LGAC vessels, as discussed in the following paragraphs. After IX, caustic is used to restore the water pH to original levels.

Due to uncertainties in future Cr+6 limits that are currently being developed, IX was used for initial Cr+6 removal. The need for this treatment step should be evaluated during the remedial design stage and consideration of sole reliance on RO for Cr+6 should be considered.

After removal of Cr+6 in the IX process, hydrogen peroxide is injected into the feed stream to the AOP treatment module at a typical injection rate of about 25 ppm. AOP is designed to reduce 1,4-dioxane from about 13 to 2 ppb. Although the target treatment level is 3 ppb for this contaminant, a treatment target level of 2 ppb is assumed for design purposes. The full design power requirement for the UV lights is about 49 kW while the average is about 32 kW.

As in Alternative 2, AOP will also remove iron and manganese by oxidizing it in the form of a precipitate. This precipitate can foul UV lamps within the AOP unit. AOP units can be provided with automatic UV lamp cleaning mechanisms to mitigate this problem. During

the future RD phase, alternative ways of dealing with potential precipitate fouling of the AOP should be considered, such as an upstream greensand filter or use of an ozone/hydrogen peroxide AOP that would not be prone to fouling the UV lamps.

For purposes of this FS, the AOP effluent is pumped through bag filters to remove any precipitates that may be formed. The bag filters would require periodic replacement. In addition, particulates will also be removed by the downstream Bio-LGAC process. As discussed later in this section, the Bio-LGAC filters would be periodically backwashed to remove both accumulated biomass and particulates not removed by the upstream bag filters as well as.

AOP also significantly reduces VOCs. In particular, alkene-type VOCs can be reduced over 80 percent, while alkane-type VOCs can be reduced in the range of 10 to 20 percent. These VOC reductions reduce the contaminant load on the downstream LGAC system.

As in Alternative 2, a similar Bio-LGAC treatment process is provided to remove these recalcitrant type organic constituents produced in AOP. Five Bio-LGAC beds (four operating plus one spare) are provided in a parallel configuration for Alternative 3 compared to Alternative 2. Each vessel is approximately 10 feet in diameter and contains about 20,000 pounds of carbon. The Bio-LGAC process is operated in the same manner as in Alternative 2.

As in Alternative 2, the Bio-LGAC effluent is further treated in a conventional LGAC process for removal of remaining VOCs. Five parallel trains (four operating plus one spare) of two LGAC vessels per train (in lead/lag configuration), with each vessel approximately 10 feet in diameter and containing about 20,000 pounds of GAC, are provided. Because of the relatively low level of VOC concentrations in the LGAC influent after upstream AOP and Bio-LGAC treatment, conventional LGAC treatment for removal of residual VOCs was assumed for the treatment process over air stripping. In general, LGAC is more economical in treating lower concentrations of VOCs, whereas air stripping is more economical in treating higher levels of VOCs, all things being equal. During the remedial design phase, both air stripping and LGAC VOC treatment processes should be evaluated in more detail to determine the most appropriate treatment process. The cost and performance of both systems would be expected to be similar.

When the LGAC becomes saturated with VOCs, the carbon must be replaced. Based on the average operating conditions assumed to be represented by the flow-weighted average concentrations of groundwater from LE, CE, and NE, the LGAC would last about 90 days between carbon change outs. This preliminary carbon usage estimate is based on 1,2-DCA being the controlling contaminant for carbon usage estimating purposes.

If required, the LGAC can be periodically backwashed with water from the treated water tank. The backwash water is handled in the same manner as that described for Bio-LGAC backwashing, except the amount of solids in the backwash water will be much less compared to Bio-LGAC backwash water.

RO is proposed to reduce selenium, aluminum, TDS, and  $\text{SO}_4$  to meet reclaimed water standards. Selenium, TDS, and  $\text{SO}_4$  (which is a constituent of TDS) must be reduced from levels of about 11.9  $\mu\text{g/L}$ , 86.6  $\mu\text{g/L}$ , 1,100  $\text{mg/L}$ , and 340  $\text{mg/L}$ , respectively, to less than 5  $\mu\text{g/L}$ , 50  $\mu\text{g/L}$ , 500  $\text{mg/L}$ , and 250  $\text{mg/L}$ , respectively.

This is accomplished by sending approximately 50 percent of the total flow or about 1,000 gpm to an RO process for removal of essentially all the selenium, aluminum, TDS, and associated  $\text{SO}_4$ , and then recombining the RO product water (permeate) with water that was bypassed around the RO system such that the blended water meets or exceeds reclaimed water quality requirements. RO will reduce most constituents from 80 to over 99 percent, depending upon the constituent. Use of a bypass stream around the RO process and subsequent reblending of RO treated water with non-RO treated water minimizes the size of the RO unit needed to reduce TDS and  $\text{SO}_4$ .

To prevent biofouling of the RO membranes by microorganisms in the Bio-LGAC effluent, a biocide is added to the RO feedwater. The biocide is injected into the water using an inline mixer and fed to a 20,000-gallon RO feed tank.

The RO system is a complete, skid-mounted system and includes all provisions for feed and effluent pH adjustment, antiscalent chemical injection, and CIP systems for proper O&M of the RO system.

The RO system has an overall recovery of about 75 percent and corresponding waste reject stream of about 25 percent of the total feed to RO. Over 90 percent of the TDS, including  $\text{SO}_4$ , will be concentrated in the brine reject stream. The brine reject stream of about 250 gpm at design flow rates (about 160 gpm at average flow rates) will be pumped to an industrial sewer trunk line located near the intersection of Norwalk Boulevard and Florence Avenue. This sewer trunk line discharges to the Joint Water Pollution Control Plant in Carson for eventual discharge to the Pacific Ocean after standard POTW treatment. Currently, there are no limits on TDS for this discharge.

Recovered water from the RO system is combined with RO bypass water in a 30,000-gallon treated water tank. The treated water is subsequently pumped to a nearby reclaimed water trunk line owned and operated by CBMWD and located at the intersection of Norwalk Boulevard and Florence Avenue. No disinfection is required because the source of water is groundwater and not a municipal wastewater source. The treated water tank is provided for surge capacity and to provide a source of clean water for backwashing Bio-LGAC, LGAC, and for cleaning the RO system. These details are not shown on the simplified process flow diagram.

A conventional RO recovery rate of 75 percent was assumed for this alternative. The RO recovery rate can be increased by adding additional RO stages, at additional cost. During the future RD phase, a more rigorous analysis should be done to identify an RO system that provides an optimum RO recovery rate versus cost. In addition, during the RD phase, a more detailed analysis and membrane system modeling should be done to confirm pretreatment requirements to deal with potential membrane fouling problems.

Overall, the GWTP has a design capacity to produce about 1,750 gpm of reclaimed water with an average production of about 1,140 gpm. At the same time, the treatment plant will produce about 250 gpm of waste brine at design rates with an average rate of about 160 gpm.

The environmental footprint of this alternative, if selected for implementation, will be revisited at the RD phase and green remediation principles will be integrated into the design and operation of the groundwater pumping and treatment. During the RD phase, the

environmental footprint of the remedy will be reduced to the maximum extent practicable to ensure that protection of human health and the environment occurs as described for Alternative 2.

### 3.3.4 Alternative 4—Plumewide Extraction with Reinjection

#### 3.3.4.1 Overview of Alternative 4

Alternative 4 is similar to Alternative 3 with the exception that the treated water will be reinjected into the deep aquifer instead of being discharged to a reclaimed water line or used for drinking water. The replenishment of the drinking water aquifers under this alternative would be consistent with water conservation efforts in the Central Basin. Groundwater monitoring is also needed under this alternative to measure the system performance and to provide early warning of upgradient changing conditions that could adversely affect system performance. The locations of extraction wells, conveyance pipelines, injection wells, and the treatment plant are shown in Figure 3-7.

ICs would include notifications and coordination discussed in Section 3.2.1.

#### 3.3.4.2 Extraction Wells, Conveyance Pipelines, and Monitoring Wells

The extraction system under this alternative is the same as for Alternative 3 and assumes two CE wells with an extraction rate of approximately 250 gpm each, two NE wells with an extraction rate of approximately 250 gpm each, and three LE wells with an extraction rate of approximately 350 gpm each; the total extraction rate is 2,050 gpm (nominally 2,000 gpm) for the plumewide extraction. The assumed locations for LE extraction are shown in Figure 3-7. The exact locations for the extraction wells would depend on future land uses and are subject to practical limitations such as access. The extraction well pumps would each be equipped with a VFD to allow for adjustment of the pumping rate in response to changes needed to maintain containment.

Conveyance pipelines will be provided as shown in Figure 3-7. The pipeline routing is exactly the same as for Alternative 3, except that, instead of needing a pipeline to convey treated water to a nearby reclaimed water trunk line, the treated water is pumped to new, nearby injection wells in the vicinity of the GWTP. These pipelines are summarized in Table 3-1.

Groundwater monitoring under this alternative is the same as for Alternative 3. The monitoring wells would generally be monitored on a quarterly basis for the first 2 years and the monitoring frequency could be reduced to semiannually thereafter. However, depending on state agency acceptance and stakeholder negotiations, a more extensive monitoring program may have to be implemented, including the potential installation of wells screened in the deep aquifer.

#### 3.3.4.3 Treatment Plant Influent Concentration and Discharge Limits

The treatment plant influent concentrations are the same as for Alternative 3 because the same plumewide extraction scenario is assumed. The discharge limits, however, are much more stringent due to aquifer anti-degradation policies. As previously stated, the quality of the re-injected water must meet or exceed the quality of groundwater in the deep drinking water aquifer. Accordingly, for purposes of the FS, it is assumed that all the COCs identified

in Table 5-5-Summary of OU2 Detections in the RI part of this report (CH2M HILL, 2010) must be reduced to concentrations that do not exceed those in existing deep aquifer groundwater. In addition, the treatment system must also reduce those COCs in the treated water to nondetect (ND) levels if they are not currently present in the deep aquifer groundwater.

The treatment plant design influent concentrations and design discharge limits for this alternative are summarized in Table 3-4. Table 3-4 is a subset of COCs from Table 5-5 in the RI and is focused on COCs that are downgradient of the former Omega Chemical facility. In developing the reinjection water discharge limits, the 2008 Annual Water Quality Report from the City of Santa Fe Springs was reviewed as a means of assessing the existing deep groundwater quality. However, the water quality data presented in the report were very limited in that only two VOCs were identified. The report did not address the presence of other COCs that might be in their groundwater supply at concentrations below regulatory limits. Any identified COC in the extracted groundwater would have to be reduced to ND levels if it was not present in the deep aquifer groundwater. The implementation of this alternative will require more complete characterization of the groundwater quality in the deep aquifer in this area based on analysis of water from the existing production wells or newly installed monitoring wells during the remedial design phase.

It is also noted that the groundwater analytical data available for use in this FS for developing design treatment plant influent concentrations were based on water sample analysis using EPA environmental analytical methods. EPA environmental analytical methods generally have higher analyte detection and reporting limits compared to drinking water analytical methods or other available analytical methods with even lower detection and reporting limits than drinking water methods. Consequently, during the remedial design phase, the influent and effluent water quality data used for design should be based on analytical methods with the lowest detection and reporting limits available to determine what COCs exist in the deep aquifer.

#### 3.3.4.4 Treatment Plant Process

The treated water used for reinjection must have COC concentrations that are no greater than the water quality in the existing aquifer. Based on the currently available information about water quality in the deep aquifer, the treatment system was design based on the information presented in Table 3-4.

The proposed treatment process is the same as in Alternative 2 with the exception that RO is used instead of NF as the final treatment step and final product water is injected into the deep aquifer instead of being reused as reclaimed water. The process is summarized in Figure 3-6 and includes the following key process steps:

- AOP for 1,4-dioxane removal using UV light and hydrogen peroxide; some VOCs removed; some partial oxidation byproducts potentially formed
- Bag filters for removal of precipitates (Fe, Mn) potentially formed in the AOP
- Bio-LGAC for removal of potential recalcitrant partial oxidation products formed in the AOP

- LGAC for removal of residual VOCs
- RO treatment for reduction of Cr+6, selenium, aluminum, TDS, SO<sub>4</sub>, and other COCs to meet or exceed existing deep aquifer water quality
- Addition of injection well and water conditioning chemicals, as needed, to restore injection well performance and minimize fouling/plugging
- Discharge of treated water (RO permeate) to injection wells for replenishment of the deep aquifer
- Discharge of RO reject brine to industrial sewer trunk line near intersection of Norwalk Boulevard and Florence Avenue

The treatment plant design flow capacity is nominally 2,000 gpm while the average flow rate is about 1,300 gpm. The hydraulic capacity of the treatment plant is about 10 percent larger than the 1,800-gpm GWTP in Alternative 2.

In the process, extracted groundwater is pumped to an onsite storage tank to provide surge capacity. The water is pumped through bag filters for removal of any particulates down to about 10 microns prior to treatment in the AOP unit.

The AOP unit is designed to reduce 1,4-dioxane from about 13 ppb to ND levels, which has been assumed to be 0.05 ppb. This treatment target is based on using one-half of a typical analytical method detection limit for 1,4-dioxane detection of 0.1 ppb. The design power requirement for the UV lights is much higher for this alternative at about 145 kW while the average is about 95 kW. At these power levels, AOP will also remove about 99 percent of the alkenes and about 20 percent to 50 percent of the alkane-type VOCs. VOC reductions in this AOP are much higher than all the other alternatives because the AOP system is more robust to achieve very low 1,4-dioxane levels required for Alternative 4.

As discussed for the previous alternatives, AOP will also remove Fe and Mn by oxidizing it in the form of a precipitate. This precipitate can foul UV lamps within the AOP unit. AOP units can be provided with automatic UV lamp cleaning mechanisms to mitigate this problem. During the future remedial design phase, alternative ways of dealing with potential precipitate fouling of the AOP unit should be considered, such as an upstream greensand filter or use of an O<sub>3</sub>/hydrogen peroxide AOP that would not be prone to fouling the UV lamps.

Bag filtration is also used after the AOP unit for removal of any potential precipitates that may be formed in the AOP as in Alternative 2. In addition, essentially the same size Bio-LGAC system provided in Alternative 2 is provided in Alternative 4, except that it is increased from four to five parallel (four operating plus one spare) Bio-LGAC vessels that are used. Similarly, the LGAC system is increased from four to five pairs of lead/lag vessel pairs. Backwash provisions would be the same as for Alternative 2. The Bio-LGAC and LGAC processes are operated in the manner as in Alternatives 2 and 3.

When the LGAC becomes saturated with VOCs, the carbon must be replaced. Based on the average operating conditions assumed to be represented by the flow-weighted average concentrations of groundwater from LE, CE, and NE, the LGAC would last about 90 days

between carbon change-outs. This preliminary carbon usage estimate is based on 1,2-DCA being the controlling contaminant for carbon usage estimating purposes.

An RO process is included as the final treatment step instead of NF before reinjection of treated water into the deep aquifer. For injection purposes, COCs must be removed to ND levels if they do not exist in the groundwater in the deep aquifer. If specific COCs already exist in the deep aquifer, the COCs in the treated water must meet or be below the concentrations already present in the deep aquifer. The RO process essentially removes all constituents to varying degrees that have not been removed by the upstream treatment process. In general, the quality of the RO-treated water will exceed the quality of water in the aquifer for most water quality parameters. Treating 100 percent of the water through RO also reduces the risk of some future emerging contaminants being identified that are not treatable by any of the upstream treatment processes. In addition, if emerging COCs require further treatment, the RO process can be augmented by adding additional stages of RO to get even higher purity water, as may be required.

To prevent biofouling of the RO membranes by microorganisms in the Bio-LGAC effluent, the RO feedwater is first treated with a biocide. The biocide is injected into the water using an inline mixer and fed to a 20,000-gallon RO feed tank.

The RO system is composed of two 50 percent capacity trains operating in parallel to provide a greater degree of flexibility. The RO system is a complete, skid-mounted system and includes all provisions for feed and effluent pH adjustment, antiscalent chemical injection, and CIP systems for proper operation and maintenance of the RO system.

The RO system has an overall recovery of about 75 percent and corresponding waste reject stream of about 25 percent of the total feed to RO. The brine reject stream of about 500 gpm at design flow rates (325 gpm at average flow rates) will be pumped to an industrial sewer trunk line located near the intersection of Norwalk Boulevard and Florence Avenue. This sewer trunk line discharges to the Joint Water Pollution Control Plant in Carson for eventual discharge to the Pacific Ocean after standard POTW treatment. Currently, there are no limits on Cr+6 or TDS for this discharge.

A conventional RO recovery rate of 75 percent was assumed for this alternative. The RO recovery rate can be increased by adding additional RO stages, at additional cost. During the future RD phase, a more rigorous analysis should be done to identify an RO system that provides an optimum RO recovery rate versus cost. Also, during the RD phase, a more detailed RO system analysis using membrane system modeling should be done to confirm pretreatment requirements to deal with potential membrane fouling problems.

As previously noted, there is uncertainty regarding the COC concentrations in the extracted groundwater because EPA environmental analytical methods that have relatively high detection levels were used for analysis instead of drinking water analytical methods that have relatively lower detection limits. Accordingly, future analysis using drinking water methods performed at the RD stage may identify more COCs. Although RO is effective for removal of most constituents in water, some constituents are removed more effectively than others. Consequently, during the RD phase, the potential need for a second stage of RO to remove all COCs to ND or to lower levels than may already be present in the deep aquifer should be thoroughly investigated.

RO-treated water is collected in a 30,000-gallon storage tank that provides surge capacity and a source of clean water for backwashing Bio-LGAC, LGAC, and for cleaning the RO system. The treated water is subsequently pumped into new reinjection wells in the immediate vicinity of the GWTP. Provisions to add injection well cleaning and water conditioning chemicals to the treated water to restore injection well performance and to minimize/reduce injection well fouling are included in the process.

Two 1,000-gpm-capacity injection wells are provided. To prevent adverse impacts on the efficiency of the extraction system, the treated groundwater will be injected deep into the aquifer at a depth greater than 400 feet bgs. The overall injection well depth will be about 500 feet bgs. The required total depth and length of the screen interval for the injection wells depend on the encountered lithology of the deep aquifer zone and should be determined at the design phase.

Overall, the GWTP has a design capacity to produce about 1,500 gpm of injection water with an average production of about 975 gpm. At the same time, the treatment plant will produce about 500 gpm of waste brine at the design rate and about 325 gpm at the average flow rate.

The environmental footprint of this alternative, if selected for implementation, will be revisited at the RD phase and green remediation principles will be integrated into the design and operation of the groundwater pumping and treatment. During the RD phase, the environmental footprint of the remedy will be reduced to the maximum extent practicable to ensure that protection of human health and the environment occurs as described for Alternative 2.

### 3.3.5 Alternative 5—Plumewide Extraction with Discharge to Spreading Basins

#### 3.3.5.1 Overview of Alternative 5

Alternative 5 is similar to Alternatives 3 and 4 with regard to the extraction scenario but differs in that the treated water will be delivered to the San Gabriel Spreading Basin for infiltration. More specifically, the treated water would be discharged to the unlined portions of the San Gabriel River that are part of the regional spreading basin area. From there, the treated water infiltrates into the deep drinking water aquifers of the Central Basin. The replenishment of the drinking water aquifers under this alternative would be consistent with water conservation efforts in the Central Basin. Groundwater monitoring is also needed under this alternative to measure the system performance and to provide early warning of upgradient changing conditions that could adversely affect system performance. The locations of extraction wells, conveyance pipelines, and treatment plant are shown in Figure 3-9.

ICs would include notifications and coordination discussed in Section 3.2.1.

#### 3.3.5.2 Extraction Wells, Conveyance Pipelines, and Monitoring Wells

The extraction system under this alternative assumes two CE wells with an extraction rate of approximately 250 gpm each, two NE wells with extraction rate of approximately 250 gpm each, and three LE wells with extraction rate of approximately 350 gpm each; the total extraction rate is 2,050 gpm (nominally 2,000 gpm) for the plumewide extraction. The assumed locations for LE extraction are shown in Figure 3-9. The exact locations for the

extraction wells would depend on future land uses and are subject to practical limitations such as access. The extraction well pumps would each be equipped with a VFD to allow for adjustment of the pumping rate in response to changes needed to maintain containment.

The spreading basin is closed for maintenance for approximately 1 month each year. During the RD phase, a more rigorous evaluation of spreading basin unavailability as a result of maintenance, rehabilitation, and storm events should be done. This is needed to establish a design flow rate that will provide an annual average extraction rate consistent with the groundwater modeling requirements for plume containment. This alternative assumes a 10 percent unavailability factor, as a rough approximation.

Conveyance pipelines will be provided as shown in Figure 3-9. Relatively long pipelines will be needed to convey groundwater from the LE and NE extraction areas to the centralized GWTP, whereas a relatively short pipeline from the CE extraction wells to the centralized GWTP will be needed. Similarly, a pipeline is needed to convey waste reject brine from a membrane treatment process at the GWTP to an industrial sewer trunk line near the intersection of Norwalk Boulevard and Florence Avenue.

In addition, a pipeline will be needed to convey treated water to an unlined portion of the San Gabriel River for infiltration purposes. Currently, LACSD operates a series of seven inflatable dams along the unlined portions of the San Gabriel River between the San Jose WRP and Firestone Boulevard. The river is concrete-lined beyond Firestone Boulevard. Any water flowing in this lined portion of the river is sent to the Pacific Ocean.

Based on preliminary discussions with LACSD, a potential discharge point is located behind the third from the last inflatable dam located north of Telegraph Road along the river channel. Accordingly, a treated water pipeline from the GWTP to this location is provided as shown in Figure 3-9. These pipelines are summarized in Table 3-1.

Groundwater monitoring under this alternative is also needed to (1) provide information to monitor the effectiveness of the containment system and to optimize the system performance and (2) provide early warnings of upgradient changing conditions that could adversely affect system performance or necessitate system modifications, such as changing groundwater flow conditions, changing contaminant concentrations, or detection of new contaminants.

It is assumed that the existing groundwater monitoring network at Omega OU2 is sufficient to fulfill the second monitoring objective. However, additional monitoring wells complementing the current monitoring network are needed downgradient of the LE extraction wells to fulfill the first monitoring objective. For cost estimation, this alternative assumes that a total of 10 clusters of wells will be installed at locations downgradient of the LE, CE, and NE wells, with each well cluster assuming four wells installed at different depths within the contaminated aquifer. The monitoring well locations would be determined during the RD.

For the purpose of estimating costs, it was assumed that the monitoring wells would generally be monitored on a quarterly basis for the first 2 years and the monitoring frequency could be reduced to semiannually thereafter.

### 3.3.5.3 Treatment Plant Influent Concentration and Discharge Limits

The treatment plant influent concentrations are the same as for Alternatives 3 and 4 because the same plumewide extraction scenario is assumed. As in Alternative 3, the same simplifying assumptions are made with regard to estimating representative design influent COC concentrations into the treatment plant and are summarized as follows:

- LE Flow Contribution – 50 percent of total flow using MW27A and MW27B concentrations as representative of LE extracted groundwater; furthermore, highest values of COCs detected between these two wells are used to approximate LE water quality
- CE Flow Contribution – 25 percent of total flow using MW26B COC concentrations as representative of CE extracted groundwater
- NE Flow Contribution – 25 percent of total flow using MW23A and MW23C concentrations as representative of NE extracted groundwater

During the RD phase, a more rigorous approach for estimating treatment plant design influent concentrations should be used based on more complete groundwater sampling data that should become available in the near future. A summary of COC concentrations of the extracted and blended groundwater influent to the GWTP is presented in Table 3-5. Reclaimed water discharge standards are also shown that serve as design treatment criteria for the GWTP.

### 3.3.5.4 Treatment Plant Process

The COCs listed in Table 3-5 must be reduced to NPDES discharge standards. The treatment process is the same as Alternative 3, except that the treated water is sent to spreading basin facilities in unlined portions of the San Gabriel River as described previously. In addition, the flow rate for Alternative 5 is also larger than Alternative 3 nominal design flow rate of about 2,000 gpm. For Alternative 5, a design flow rate of about 2,200 gpm is needed to account for about 5 weeks per year of spreading basin unavailability. However, the average annualized extraction rate is the same as for Alternative 3 at about 1,300 gpm.

The proposed treatment process is the same as in Alternative 3 with the exception that final product water is sent to spreading grounds and treatment design capacity is about 10 percent higher. The proposed treatment process is summarized in Figure 3-8 and includes the following key process steps, as used in Alternative 3:

- Cr+6 removal using IX with pH adjustment before and after IX
- AOP for 1,4-dioxane removal using UV light and hydrogen peroxide; some VOCs removed; some partial oxidation byproducts potentially formed
- Bag filters for removal of precipitates (Fe, Mn) potentially formed in the AOP
- Bio-LGAC for removal of potential recalcitrant partial oxidation products formed in the AOP
- LGAC for removal of residual VOCs

- RO treatment of about 50 percent of the flow stream for reduction of selenium, aluminum, TDS, and SO<sub>4</sub>
- Blending of RO-treated RO bypass water to meet Cr+6, selenium, aluminum, TDS, and SO<sub>4</sub> discharge limits
- Discharge of blended water (RO permeate plus RO bypass) to spreading basin areas in unlined portions of the San Gabriel River
- Discharge of RO reject brine to industrial sewer trunk line near the intersection of Norwalk Boulevard and Florence Avenue

Based on a design flow rate of about 2,200 gpm, the treatment process will produce about 1,925 gpm of treated water for spreading basin use and a corresponding design waste brine flow of about 275 gpm. Annualized average flow of treated water is about 1,300 gpm and corresponding average waste brine flow is about 160 gpm as in Alternative 3. The waste brine flow would be conveyed to an industrial sewer line that discharges to the Joint Water Pollution Control Plant in Carson for eventual discharge to the Pacific Ocean after standard POTW treatment.

Details of the treatment processes are described in Alternative 3. The treatment equipment is slightly larger as previously noted to accommodate a 2,200-gpm design flow rate.

Due to uncertainties in future hexavalent chromium limits that are currently being developed, IX was used for initial Cr+6 removal. The need for treatment step should be evaluated during the remedial design stage and consideration of sole reliance on RO treatment for Cr+6 should be considered.

As in Alternative 3, a conventional RO recovery rate of 75 percent was assumed. The RO recovery rate can be increased to higher levels, perhaps as high as 90 percent, by adding additional RO stages; however, at additional cost. During the future remedial design phase, a more rigorous analysis should be done to identify an RO system that provides an optimum RO recovery rate versus cost. Also, during the remedial design phase, a more-detailed RO analysis including membrane system modeling should be done to confirm pretreatment requirements to deal with potential membrane fouling problems.

The environmental footprint of this alternative, if selected for implementation, will be revisited at the RD phase and green remediation principles will be integrated into the design and operation of the groundwater pumping and treatment. During the RD phase, the environmental footprint of the remedy will be reduced to the maximum extent practicable to ensure that protection of human health and the environment occurs as described for Alternative 2.

### **3.3.6 Alternative 6—Plumewide Extraction with Drinking Water End Use**

#### **3.3.6.1 Overview of Alternative 6**

Alternative 6 is similar to Alternatives 3, 4, and 5 because it incorporates the same plumewide extraction scenario with groundwater extraction at the LE, CE, and NE areas. Alternative 6 is similar to Alternative 2 in that groundwater will be treated and distributed to a municipal water supply system as drinking water. Extracted groundwater will be

treated with a centralized GWTP located in the vicinity of the CE area. The drinking water end use under this alternative would be consistent with regional efforts to reduce the amount of potable water that is imported into Southern California. Groundwater monitoring is needed under this alternative to measure the system performance and to provide early warning of upgradient changing conditions that could adversely affect system performance. The locations of extraction wells, conveyance pipelines, and the treatment plant are shown in Figure 3-11.

ICs would include notifications and coordination discussed in Section 3.2.1.

### 3.3.6.2 Extraction Wells, Conveyance Pipelines, and Monitoring Wells

The extraction system under this alternative is the same as for Alternatives 3, 4, and 5 and assumes two CE wells with an extraction rate of 250 gpm each, two NE wells with an extraction rate of approximately 250 gpm each, and three LE wells (represented by two wells in the numerical model) with an extraction rate of approximately 350 gpm each; the total extraction rate is 2,050 gpm (nominally 2,000 gpm) for the plumewide extraction. The exact locations for the extraction wells will be determined during the remedial design and would depend on future land uses and practical limitations such as access. The extraction well pumps would each be equipped with a VFD to allow for adjustment of the pumping rate in response to changes needed to maintain containment.

Conveyance pipelines will be provided as shown in Figure 3-11. Relatively long pipelines will be needed to convey groundwater from the LE and NE extraction areas to the centralized GWTP, whereas a relatively short pipeline from the CE extraction wells to the centralized GWTP will be needed.

In addition, a pipeline will be needed to convey treated potable water to the same existing 4-MG water tank as in Alternative 2. This potable water tank is owned and operated by the City of Santa Fe Springs and is located near the intersection of Florence Avenue and Bloomfield Avenue for distribution. Similarly, a pipeline is needed to convey waste reject brine from a membrane treatment process at the GWTP to an industrial sewer trunk line near the same intersection noted previously. These pipelines are summarized in Table 3-1.

Groundwater monitoring under this alternative is the same as for Alternatives 3, 4, and 5. For the purpose of estimating costs, it was assumed that the new monitoring wells would generally be monitored on a quarterly basis for the first 2 years and the monitoring frequency could be reduced to semiannually thereafter. The existing groundwater monitoring network wells at OU2 would also likely require monitoring on a similar frequency, depending upon the CDPH 97-005 permit requirements. In some cases, the CDPH 97-005 permit requirements may require more frequent sampling initially, perhaps on a monthly basis for a period of time, before the sampling frequency is reduced to a quarterly basis. In addition, the CDPH 97-005 permit may also require monitoring in areas outside but in the vicinity of OU2 to provide additional early warning of potential water quality changes.

### 3.3.6.3 Treatment Plant Influent Concentration and Discharge Limits

The treatment plant influent concentrations are the same as for Alternatives 3, 4, and 5 because the same plumewide extraction scenario is used. The discharge limits are the same

as for Alternative 2 (drinking water end use). However, the number of COCs requiring treatment and their concentrations differ somewhat for Alternative 6 compared to Alternative 2 because of the difference in extraction scenarios. Alternative 6 discharge limits for specific COCs are summarized in Table 3-6. In comparing Alternative 6 discharge limits and COCs shown in Table 3-6 with the Alternative 2 discharge limits and COCs shown in Table 3-2, the following differences are noted:

- Total chromium concentration is estimated to be below its MCL limit and does not require treatment.
- All other COC concentrations are significantly higher, including 1,4-dioxane and VOCs, compared to Alternative 2.
- Four additional COCs need treatment including bis(2-Ethylhexyl) phthalate, 1,1,2-trichloroethane, aluminum, and Mn.

As noted for all the previous alternatives, during the RD phase, a more rigorous approach for estimating treatment plant design influent concentrations should be used based on more complete groundwater sampling data.

#### 3.3.6.4 Treatment Plant Process

The COCs listed in Table 3-6 must be reduced to the discharge limits listed in the table. The proposed treatment process is summarized in Figure 3-10 and includes the following key process steps similar to Alternative 2:

- AOP for 1,4-dioxane removal using UV light and hydrogen peroxide; some VOCs removed; some partial oxidation byproducts potentially formed
- Bag filters for removal of precipitates (Fe, Mn) potentially formed in the AOP
- Bio-LGAC for removal of potential recalcitrant partial oxidation products formed in the AOP
- LGAC for removal of VOCs
- NF for removal aluminum/TDS/SO<sub>4</sub>
- Disinfection using chlorination to meet potable water standards
- Discharge of treated water (NF permeate) to existing water storage tank for blending with City of Santa Fe Springs drinking water
- Discharge of NF reject brine to industrial sewer trunk line near intersection of Bloomfield Avenue and Florence Avenue

Alternative 6 does not require treatment for total chromium because its concentration in the extracted groundwater is less than the current MCL for total chromium (50 ppb). In contrast, Alternatives 3 through 5 have lower specific discharge limits for Cr+6 associated with their end use. However, it should be noted that the NF unit that is included in Alternative 6 primarily for TDS removal will also remove total and hexavalent chromium incidentally. For Alternative 6, the influent total chromium concentration, which is comprised primarily of CR+6, will be reduced to a concentration of about 0.6 µg/L in the treated water.

The treatment plant design flow capacity is nominally 2,000 gpm while the average flow rate is about 1,300 gpm. The hydraulic capacity of the treatment plant is about 10 percent larger than the 1,800-gpm GWTP in Alternative 2.

The treatment process is the same as described for Alternative 2, except that certain COC concentrations are higher. The AOP unit is designed to reduce 1,4-dioxane from about 13 to 2 ppb for Alternative 6 compared to a reduction from about 7 to 2 ppb for Alternative 2. Although the target treatment level is 3 ppb for this contaminant, a treatment target level of 2 ppb is assumed for design purposes. The full design power requirement for the UV lights is about 49 kW while the average is about 32 kW, similar to Alternatives 3 and 5.

For purposes of this FS, the AOP effluent is pumped through bag filters to remove any precipitates (Fe and Mn) that may be formed. The bag filters would require periodic replacement. In addition, particulates will also be removed by the downstream Bio-LGAC process. As discussed later in this section, the Bio-LGAC filters would be periodically backwashed to remove both accumulated biomass and particulates not removed by the upstream bag filters.

The AOP also significantly reduces VOCs. In particular, alkene-type VOCs can be reduced over 80 percent, while alkane-type VOCs can be reduced in the range of 10 to 20 percent. These VOC reductions reduce the contaminant load on the downstream LGAC system.

The AOP effluent is treated in a Bio-LGAC treatment process as used in all the previous alternatives to remove some partial oxidation byproducts that are not easily amenable to downstream conventional LGAC treatment.

The Bio-LGAC system downstream of the AOP unit is the same as for Alternative 2 except that a total of five parallel beds are used instead of four to handle the larger flow rate. The Bio-LGAC vessels are the same size as used in Alternative 2 and would be operated in the same manner.

The Bio-LGAC effluent is further treated in a conventional LGAC process for removal of remaining VOCs. The LGAC system is the same as for Alternative 2 except that five parallel trains (four operating plus one spare) of two LGAC vessels per train (in lead/lag configuration) are used instead of four parallel trains. The LGAC vessels are the same size as in Alternative 2 and would be operated in the same manner.

When the LGAC becomes saturated with VOCs, the carbon must be replaced. Based on the average operating conditions assumed to be represented by the flow-weighted average concentrations of groundwater from LE, CE, and NE, the LGAC would last about 90 days between carbon change outs. This preliminary carbon usage estimate is based on 1,2-DCA being the controlling contaminant for carbon usage estimating purposes.

An NF system is proposed to reduce aluminum, TDS, and  $\text{SO}_4$ . The NF system is identical to the NF system in Alternative 2, except that it is slightly larger to handle 2,000 gpm instead of 1,800 gpm.

The NF system has an overall recovery of about 75 percent and corresponding waste reject stream of about 25 percent of the total feed to NF. The waste brine stream will be pumped to an industrial sewer trunk line located near the intersection of Bloomfield Avenue and Florence Avenue as in Alternative 2. This industrial sewer line discharges to the Joint Water

Pollution Control Plant in Carson for eventual discharge to the Pacific Ocean after standard POTW treatment.

A conventional NF recovery rate of 75 percent was assumed for this alternative. The NF recovery rate can be increased by adding additional NF stages, at additional cost. During the future RD phase, a more rigorous analysis should be done to identify and analyze the cost of an NF system that provides an optimum NF recovery rate. In addition, a more-detailed analysis and membrane system modeling should be done to confirm pretreatment requirements to deal with potential membrane fouling problems.

Recovered water from the NF system is disinfected to potable standards using direct inline injection of sodium hypochlorite. A 30,000-gallon storage tank is provided for surge capacity and to provide a source of clean water for backwashing Bio-LGAC, LGAC, and for cleaning the NF system. These details are not shown on the simplified process flow diagram.

As in Alternative 2, the disinfected, potable grade water is subsequently pumped to an existing 4,000,000-gallon potable water storage tank owned by the City of Santa Fe Springs and located near the intersection of Bloomfield Avenue and Florence Avenue, for blending with the City's drinking water.

Overall, the GWTP has a design capacity to produce about 1,500 gpm of potable water with an average production of about 975 gpm. The treatment plant will produce about 500 gpm of waste brine at design capacity rates, with an average rate of about 325 gpm. Although a significant amount of waste brine is generated from the GWTP, the volume of waste brine generated can be possibly reduced during the remedial design phase by performing an NF recovery optimization study as discussed previously.

The environmental footprint of this alternative, if selected for implementation, will be revisited at the RD phase and green remediation principles will be integrated into the design and operation of the groundwater pumping and treatment. During the RD phase, the environmental footprint of the remedy will be reduced to the maximum extent practicable to ensure that protection of human health and the environment occurs as described for Alternative 2.

**Table 3-1**

Summary of Conveyance Pipelines of Active Remedial Alternatives

Remedial Alternatives	Pipeline Segment Description	Pipeline Beginning Location	Pipeline Ending Location	Approx. Pipeline Length (feet)	Avg. Flow (gpm)	Design Flow (gpm)	Pipeline Size (inches)
Alternative 2	LE Extraction Segment 1	Ext Well	GWTP	900	400	600	8
	LE Extraction Segment 2	Ext Well	GWTP	500	800	1200	10
	LE Extraction Segment 3	Ext Well	GWTP	2600	1150	1800	14
	Treated Potable Water to SFS Storage Tk	GWTP	SFS Tank	9200	900	1350	12
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	9200	300	450	8
	<i>Total</i>			22400			
Alternative 3	LE Extraction Segment 1	Ext Well	GWTP	900	230	350	6
	LE Extraction Segment 2	Ext Well	GWTP	500	470	700	8
	LE Extraction Segment 3	Ext Well	GWTP	14700	700	1050	12
	CE Extracted Water Pipeline	Ext Well	GWTP	4500	350	500	8
	NE Extracted Water Pipeline	Ext Well	GWTP	6100	350	500	8
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	6000	163	250	6
	Reclaim Water to Trunk Line Tie-In @ Florence	GWTP	Florence Ave	6000	1138	1750	14
	<i>Total</i>			38700			
Alternative 4	LE Extraction Segment 1	Ext Well	GWTP	900	230	350	6
	LE Extraction Segment 2	Ext Well	GWTP	500	470	700	8
	LE Extraction Segment 3	Ext Well	GWTP	14700	700	1050	12
	CE Extracted Water Pipeline	Ext Well	GWTP	4500	350	500	8
	NE Extracted Water Pipeline	Ext Well	GWTP	6100	350	500	8
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	6000	325	500	8
	Treated Water to Injection Wells	GWTP	Injection wells	500	975	1500	14
	<i>Total</i>			33200			
Alternative 5	LE Extraction Segment 1	Ext Well	GWTP	900	230	375	6
	LE Extraction Segment 2	Ext Well	GWTP	500	470	750	8
	LE Extraction Segment 3	Ext Well	GWTP	14700	700	1125	12
	CE Extracted Water Pipeline	Ext Well	GWTP	4500	330	540	8
	NE Extracted Water Pipeline	Ext Well	GWTP	6100	330	540	8
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	6000	163	275	6
	Treated Water to San Gabriel River	GWTP	S. G River	9200	1138	1925	14
	<i>Total</i>			41900			
Alternative 6	LE Extraction Segment 1	Ext Well	GWTP	900	230	350	6
	LE Extraction Segment 2	Ext Well	GWTP	500	470	700	8
	LE Extraction Segment 3	Ext Well	GWTP	14700	700	1050	12
	CE Extracted Water Pipeline	Ext Well	GWTP	4500	350	500	8
	NE Extracted Water Pipeline	Ext Well	GWTP	6100	350	500	8
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	6000	325	500	8
	Treated Potable Water to SFS Storage Tk	GWTP	SFS Tank	8000	975	1500	14
	<i>Total</i>			40700			



TABLE 3-2

Alternative 2 – Treatment Plant Design Basis and Average Influent Concentrations With Drinking Water Discharge Limits

*Omega Chemical Corporation Superfund Site*

Contaminant <sup>1</sup>	Drinking Water Discharge Limits for Key COCs	Unit	Design Influent Concentration for 1st 15 Yrs Operation (1/2 of MW26B Conc.) [Also used as Average Conc. for O&M] <sup>4</sup>	Design Influent Concentration for 2nd 15 Yrs Operation (100% of MW26B Conc.)
1,4-Dioxane (dioxane)	3	µg/L	3.6 <sup>3</sup>	7.1 <sup>3</sup>
1,1-Dichloroethane	5	µg/L	7.5	15
Tetrachloroethene	5	µg/L	75	150
Trichloroethene	5	µg/L	55	110
1,1-Dichloroethene	6	µg/L	39	78
1,2-Dichloroethane	0.5	µg/L	1.6	3.2
cis-1,2-Dichloroethene	6	µg/L	17	34
Total Chromium <sup>5</sup>	50	µg/L	26	52
Nitrate (as Nitrogen) <sup>2</sup>	10	mg/L	9.9	9.9
Sulfate <sup>2</sup>	250	mg/L	322	322
Total Dissolved Solids <sup>2</sup>	500	mg/L	1,105	1,105

Notes:

<sup>1</sup> Influent concentrations for the contaminants of concern (COCs) are estimated based on samples taken in the 3rd Quarter of 2007 using Well MW26B as a surrogate for extracted water at the leading edge (LE); if a given analyte was not available, the most recent value from previous time periods was used.

<sup>2</sup> Influent concentrations for nitrate (as nitrogen), sulfate, and total dissolved solids are the corresponding median values of all Omega wells.

<sup>3</sup> For design purposes, the higher 1,4-dioxane concentration from MW26A was used instead of from MW26B.

<sup>4</sup> These values are also assumed for average concentrations over the 30-year life of the remedy for operations and maintenance cost estimating purposes.

<sup>5</sup> Total chromium is mostly hexavalent chromium



TABLE 3-3

Alternative 3 – Treatment Plant Design Basis and Average Influent Concentrations With Reclaimed Water Discharge Limits  
*Omega Chemical Corporation Superfund Site*

Contaminant <sup>1</sup>	Reclaimed Water Discharge Limits for Key COCs	Unit	Flow-Weighted Estimated Design Basis Influent Concentrations <sup>3</sup>	Flow-Weighted Estimated Avg. O&M Influent Concentrations <sup>4</sup>
bis(2-Ethylhexyl)phthalate	4	µg/L	7.2 <sup>5</sup>	7.2
1,4-Dioxane (dioxane)	3	µg/L	13.2 <sup>5</sup>	13.2
1,1-Dichloroethane	5	µg/L	30.1 <sup>5</sup>	30.1
Tetrachloroethene	5	µg/L	380.0	255.2
Trichloroethene	5	µg/L	267.5	170.0
1,1-Dichloroethene	6	µg/L	294.5	244.3
1,2-Dichloroethane	0.5	µg/L	8.1	7.2
1,1,2-Trichloroethane	5	µg/L	6.0 <sup>5</sup>	6.0
cis-1,2-Dichloroethene	6	µg/L	84.2 <sup>5</sup>	84.2
Aluminum	50	µg/L	86.6	24.5
Chromium(VI)	8	µg/L	19.2	11.2
Manganese	50	µg/L	534.5 <sup>5</sup>	534.5
Selenium	5	µg/L	11.9 <sup>5</sup>	11.9
Nitrate (as Nitrogen) <sup>2</sup>	10	mg/L	9.9	9.9
Sulfate <sup>2</sup>	250	mg/L	339	339
Total Dissolved Solids <sup>2</sup>	500	mg/L	1105	1105

Notes:

<sup>1</sup> Influent concentrations for the contaminants of concern (COCs) are estimated based on samples taken in the 3rd Quarter of 2007; if a given analyte was

<sup>2</sup> Influent concentrations for nitrate (as nitrogen), sulfate, and total dissolved solids are the corresponding median values of all Omega wells.

<sup>3</sup> Design flow-weighted concentrations are based on 50%, 25%, and 25% flow contributions from LE, CE, and NE extraction areas, respectively; where LE concentrations are based on the highest value between MW 27A and MW27B; where CE concentrations are based on MW26B; and where NE concentrations are based on the highest value between MW23A and MW23C.

<sup>4</sup> Average flow-weighted averages are based on 50%, 25%, and 25% flow contributions from LE, CE, and NE extraction areas, respectively; where LE concentrations are based on the highest value measured at MW27A & MW27B; where concentrations at CE are based on the average COC concentrations in MW10, MW11, MW16B, MW17A, MW19, MW25B, and MW26B; and where concentrations at NE are based on the average concentration values of COCs in wells MW4A, MW5, MW6, MW7, MW8A, MW15, MW23A, and MW23C.

<sup>5</sup> When an estimated design basis influent concentration for a specific COC based on the assumptions above is lower than the calculated average concentration, then the higher average concentration is used for the design basis as well. For this reason, the design concentrations and the average concentrations are equal for some COCs.



TABLE 3-4

Alternative 4 – Treatment Plant Design Basis and Average Influent Concentrations with ReInjection Water Discharge Limits  
*Omega Chemical Corporation Superfund Site*

Contaminant <sup>1</sup>	ReInjection Water Discharge Limits for Key COCs <sup>6</sup>	Unit	Estimated Design Base Influent Concentrations <sup>4</sup>	Estimated O&M Influent Concentrations <sup>5</sup>
bis(2-Ethylhexyl)phthalate	4	µg/L	7.2 <sup>5</sup>	7.2
1,4-Dioxane (dioxane)	ND	µg/L	13.2 <sup>5</sup>	13.2
1,1-Dichloroethane	5	µg/L	30.1 <sup>5</sup>	30.1
Tetrachloroethene	ND <sup>6</sup>	µg/L	380.0	255.2
Trichloroethene	ND <sup>6</sup>	µg/L	267.5	170.0
1,1-Dichloroethene	6	µg/L	294.5	244.3
1,2-Dichloroethane	0.5	µg/L	8.1	7.2
1,1,2-Trichloroethane	5	µg/L	6.0 <sup>5</sup>	6.0
cis-1,2-Dichloroethene	6	µg/L	84.2 <sup>5</sup>	84.2
Aluminum	ND <sup>6</sup>	µg/L	86.6	24.5
Total Chromium <sup>7</sup>	50	µg/L	19.2	11.2
Manganese	50	µg/L	534.5 <sup>5</sup>	534.5
Selenium	5	µg/L	11.9 <sup>5</sup>	11.9
Nitrate (as Nitrogen) <sup>2</sup>	5.8 <sup>6</sup>	mg/L	9.9	9.9
Sulfate <sup>2</sup>	155 <sup>6</sup>	mg/L	339	339
Total Dissolved Solids <sup>2</sup>	573 <sup>6</sup>	mg/L	1,105	1,105

Notes:

<sup>1</sup> Influent concentrations for the contaminants of concern (COCs) are estimated based on samples taken in the 3rd Quarter of 2007; if a given analyte

<sup>2</sup> Influent concentrations for nitrate (as nitrogen), sulfate, and total dissolved solids are the corresponding median values of all Omega wells.

<sup>3</sup> Design flow-weighted concentrations are based on 50%, 25%, and 25% flow contributions from LE, CE, and NE extraction areas, respectively; where LE concentrations are based on the highest value between MW 27A and MW27B; where CE concentrations are based on MW26B; and where NE concentrations are based on the highest value between MW23A and MW23C.

<sup>4</sup> Average flow-weighted averages are based on 50%, 25%, and 25% flow contributions from LE, CE, and NE extraction areas, respectively; where LE concentrations are based on the highest value measured at MW27A and MW27B; where concentrations at CE are based on the average COC concentrations in MW10, MW11, MW16B, MW17A, MW19, MW25B, and MW26B; and where concentrations at NE are based on the average concentration values of COCs in wells MW4A, MW5, MW6, MW7, MW8A, MW15, MW23A, and MW23C.

<sup>5</sup> When an estimated design basis influent concentration for a specific COC based on the assumptions above is lower than the calculated average concentration, then the higher average concentration is used for the design basis as well. For this reason, the design concentrations and the average concentrations are equal for some COCs.

<sup>6</sup> Drinking water standards are shown as "place holder" for the COC listed except for PCE, TCE, aluminum, nitrate, sulfate, and TDS; the values for these five analytes are based on the City of Santa Fe Springs 2008 Water Quality Report. Discharge limits for the other COCs are uncertain at this time for two key reasons that must be addressed in the future remedial design (RD) phase due to statewide aquifer anti-degradation policies: (1) the deep aquifer water has not yet been fully characterized; therefore, it is not known what COCs may or may not be present in the water, (2) the OU2 water quality data are based on EPA environmental analytical methods rather than drinking water methods that have lower detection limits. Consequently, it is likely that many more COPCs may be identified as being above nondetect (ND) when drinking water analytical methods are used in the future for OU2 groundwater characterization. In this case, these additional COCs will require treatment to ND levels if they are not present in the deep aquifer. As discussed in Section 3 of the FS, it is assumed that, at a minimum, all of the COCs noted above will need to be treated to ND unless otherwise noted.

<sup>7</sup> Total chromium is mostly hexavalent chromium.



TABLE 3-5

Alternative 5 – Treatment Plant Design Basis, Average Influent Concentrations, and Spreading Basin Discharge Limits  
*Omega Chemical Corporation Superfund Site*

Contaminant <sup>1</sup>	Surface Water Discharge Limits for Key COCs	Unit	Estimated Design Base Influent Concentrations <sup>3</sup>	Estimated O&M Influent Concentrations <sup>4</sup>
bis(2-Ethylhexyl)phthalate	4	µg/L	7.2 <sup>5</sup>	7.2
1,4-Dioxane (dioxane)	3	µg/L	13.2 <sup>5</sup>	13.2
1,1-Dichloroethane	5	µg/L	30.1 <sup>5</sup>	30.1
Tetrachloroethene	5	µg/L	380.0	255.2
Trichloroethene	5	µg/L	267.5	170.0
1,1-Dichloroethene	6	µg/L	294.5	244.3
1,2-Dichloroethane	0.5	µg/L	8.1	7.2
1,1,2-Trichloroethane	5	µg/L	6.0 <sup>5</sup>	6.0
cis-1,2-Dichloroethene	6	µg/L	84.2 <sup>5</sup>	84.2
Aluminum	50	µg/L	86.6	24.5
Chromium(VI)	8	µg/L	19.2	11.2
Manganese	50	µg/L	534.5 <sup>5</sup>	534.5
Selenium	5	µg/L	11.9 <sup>5</sup>	11.9
Nitrate (as Nitrogen) <sup>2</sup>	10	mg/L	9.9	9.9
Sulfate <sup>2</sup>	250	mg/L	339	339
Total Dissolved Solids <sup>2</sup>	500	mg/L	1,105	1,105

Notes:

<sup>1</sup> Influent concentrations for the contaminants of concern (COCs) are estimated based on samples taken in the 3rd Quarter of 2007; if a given analyte was not available, the most recent value from previous time periods was used.

<sup>2</sup> Influent concentrations for nitrate (as nitrogen), sulfate, and total dissolved solids are the corresponding median values of all Omega wells.

<sup>3</sup> Design flow-weighted concentrations are based on 50%, 25%, and 25% flow contributions from LE, CE, and NE extraction areas, respectively; where LE concentrations are based on the highest value between MW 27A and MW27B; where CE concentrations are based on MW26B; and where NE concentrations are based on the highest value between MW23A and MW23C.

<sup>4</sup> Average flow-weighted averages are based on 50%, 25%, and 25% flow contributions from LE, CE, and NE extraction areas, respectively; where LE concentrations are based on the highest value measured at MW27A and MW27B; where concentrations at CE are based on the average COC concentrations in MW10, MW11, MW16B, MW17A, MW19, MW25B, and MW26B; and where concentrations at NE are based on the average concentration values of COCs in wells MW4A, MW5, MW6, MW7, MW8A, MW15, MW23A, and MW23C.

<sup>5</sup> When an estimated design basis influent concentration for a specific COC based on the assumptions above is lower than the calculated average concentration, then the higher average concentration is used for the design basis as well. For this reason, the design concentrations and the average concentrations are equal for some COCs.



TABLE 3-6

Alternative 6 – Treatment Plant Design Basis and Average Influent Concentrations with Drinking Water Discharge Limits  
*Omega Chemical Corporation Superfund Site*

Contaminant <sup>1</sup>	Drinking Water Discharge Limits for Key COCs	Unit	Estimated Design Base Influent Concentrations <sup>3</sup>	Estimated O&M Influent Concentrations <sup>4</sup>
bis(2-Ethylhexyl)phthalate	4	µg/L	7.2 <sup>5</sup>	7.2
1,4-Dioxane (dioxane)	3	µg/L	13.2 <sup>5</sup>	13.2
1,1-Dichloroethane	5	µg/L	30.1 <sup>5</sup>	30.1
Tetrachloroethene	5	µg/L	380.0	255.2
Trichloroethene	5	µg/L	267.5	170.0
1,1-Dichloroethene	6	µg/L	294.5	244.3
1,2-Dichloroethane	0.5	µg/L	8.1	7.2
1,1,2-Trichloroethane	5	µg/L	6.0 <sup>5</sup>	6.0
cis-1,2-Dichloroethene	6	µg/L	84.2 <sup>5</sup>	84.2
Aluminum	50	µg/L	86.6	24.5
Total Chromium <sup>6</sup>	50	µg/L	19.2	11.2
Manganese	50	µg/L	534.5 <sup>5</sup>	534.5
Nitrate (as Nitrogen) <sup>2</sup>	10	mg/L	9.9	9.9
Sulfate <sup>2</sup>	250	mg/L	339	339
Total Dissolved Solids <sup>2</sup>	500	mg/L	1,105	1,105

Notes:

<sup>1</sup> Influent concentrations for the contaminants of concern (COCs) are estimated based on samples taken in the 3rd Quarter of 2007; if a given analyte was not available, the most recent value from previous time periods was used.

<sup>2</sup> Influent concentrations for nitrate (as nitrogen), sulfate, and total dissolved solids are the corresponding median values of all Omega wells.

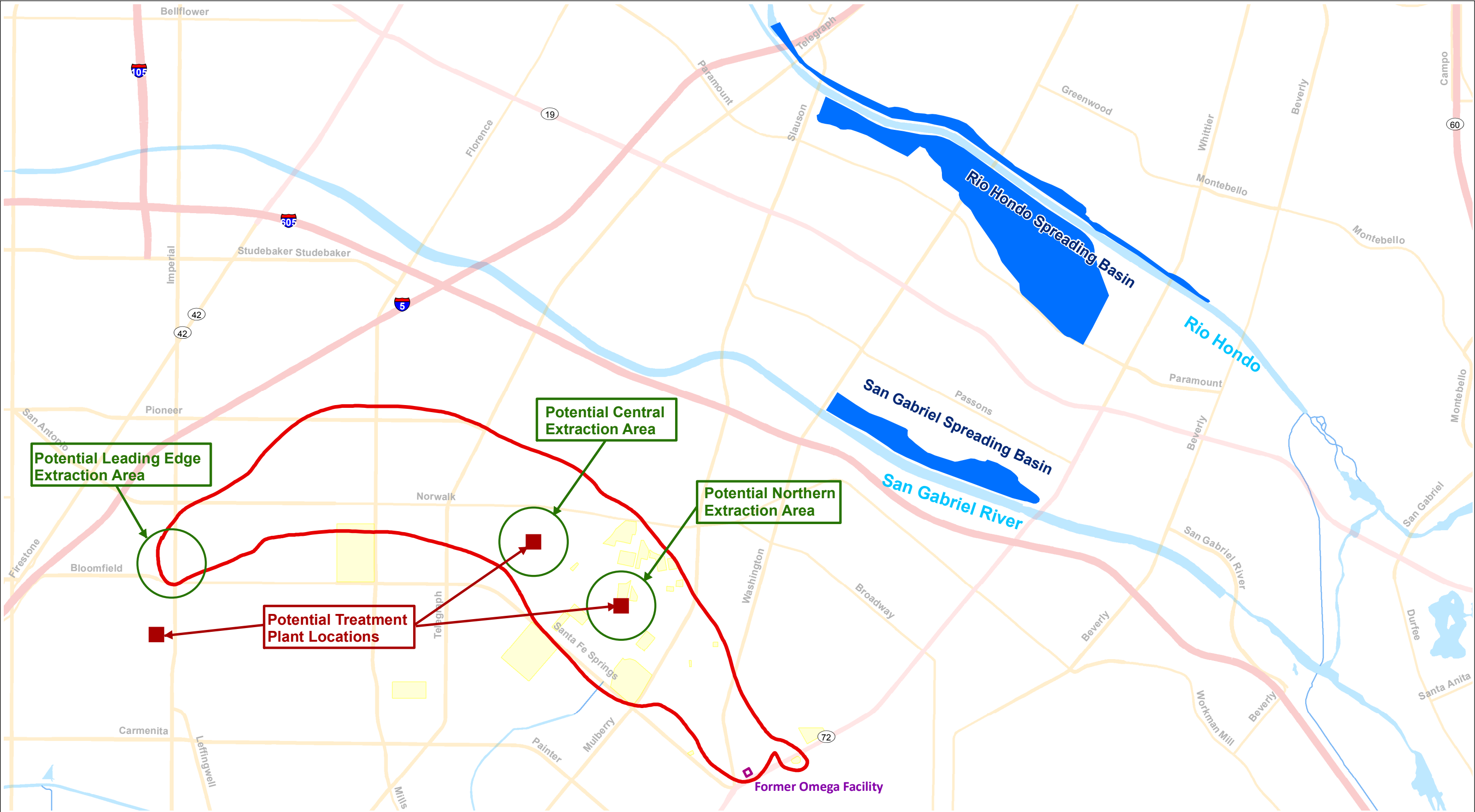
<sup>3</sup> Design flow-weighted concentrations are based on 50%, 25%, and 25% flow contributions from LE, CE, and NE extraction areas, respectively; where LE concentrations are based on the highest value between MW 27A and MW27B; where CE concentrations are based on MW26B; and where NE concentrations are based on the highest value between MW23A and MW23C.

<sup>4</sup> Average flow-weighted averages are based on 50%, 25%, and 25% flow contributions from LE, CE, and NE extraction areas, respectively; where LE concentrations are based on the highest value measured at MW27A and MW27B; where concentrations at CE are based on the average COC concentrations in MW10, MW11, MW16B, MW17A, MW19, MW25B, and MW26B; and where concentrations at NE are based on the average concentration values of COCs in wells MW4A, MW5, MW6, MW7, MW8A, MW15, MW23A, and MW23C.

<sup>5</sup> When an estimated design basis influent concentration for a specific COC based on the assumptions above is lower than the calculated average concentration, then the higher average concentration is used for the design basis as well. For this reason, the design concentrations and the average concentrations are equal for some COCs.

<sup>6</sup> Total chromium is mostly hexavalent chromium.





**Legend**

	Proposed Extraction Locations		River
	Proposed Treatment Plant Location		Former Omega Facility
	Spreading Basin		Approximate Boundary of Facilities

**Figure 3-1**  
**Proposed Extraction and Treatment Plant Locations**  
Omega OU2 Feasibility Study



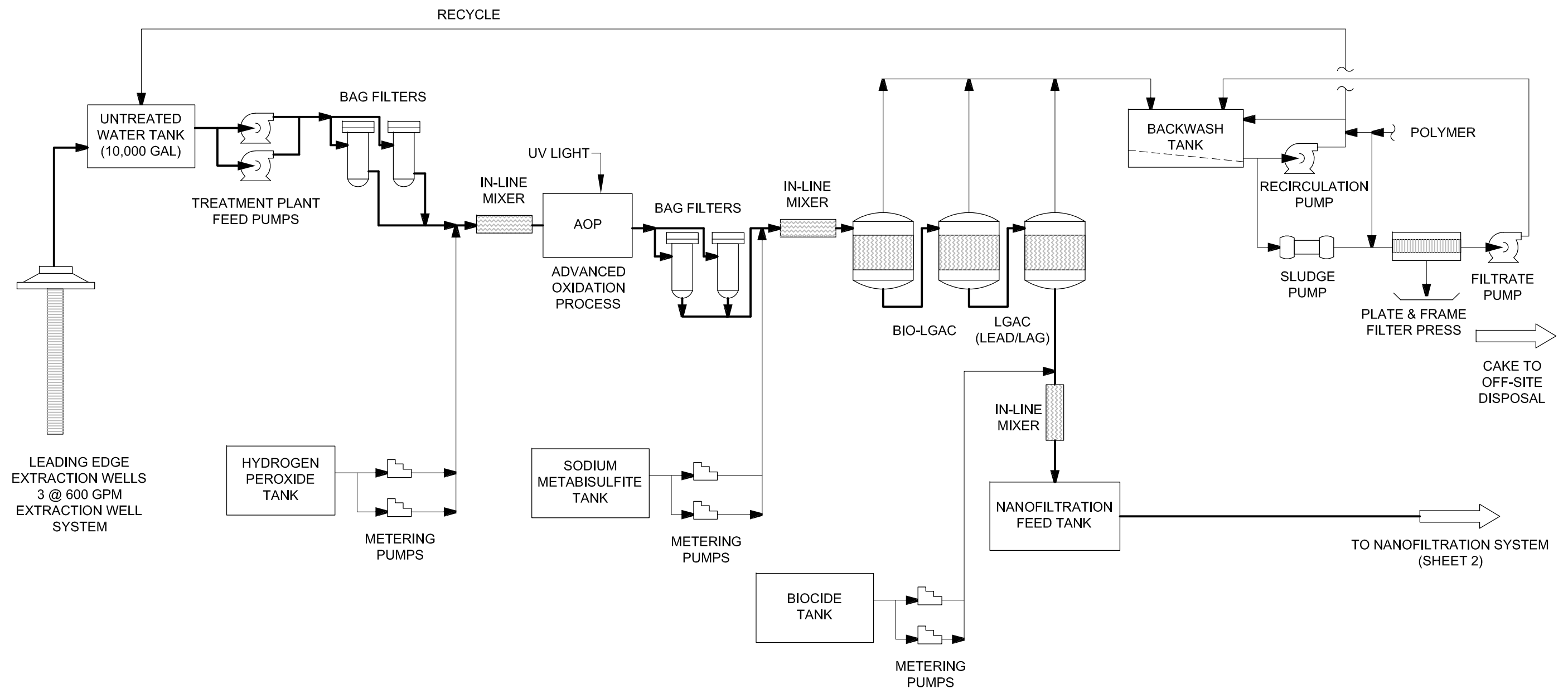


FIGURE 3-2 (SHEET 1 OF 2)  
 ALTERNATIVE 2 - LEADING EDGE EXTRACTION WITH DRINKING WATER END USE  
 SIMPLIFIED PROCESS FLOW DIAGRAM



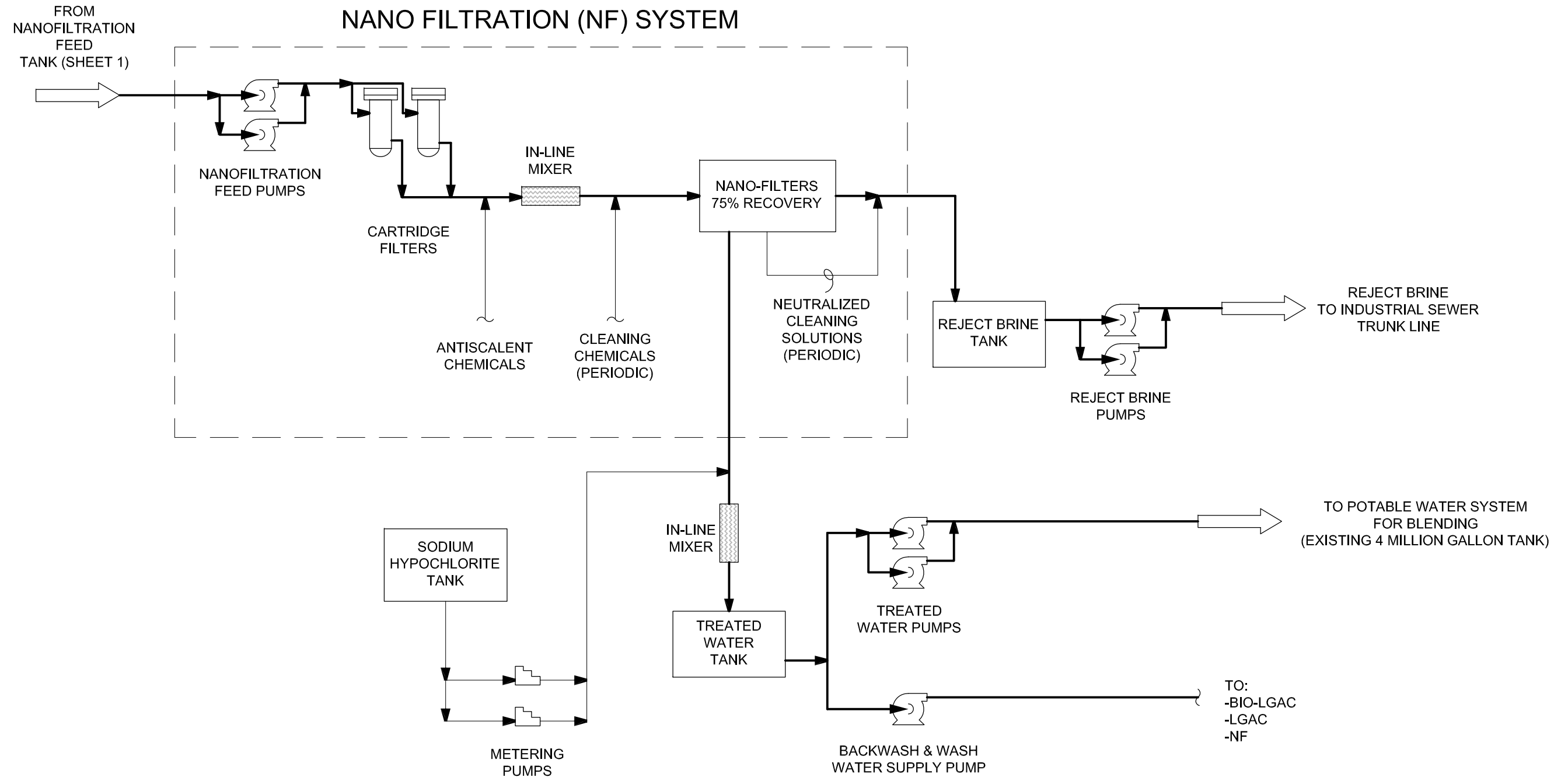
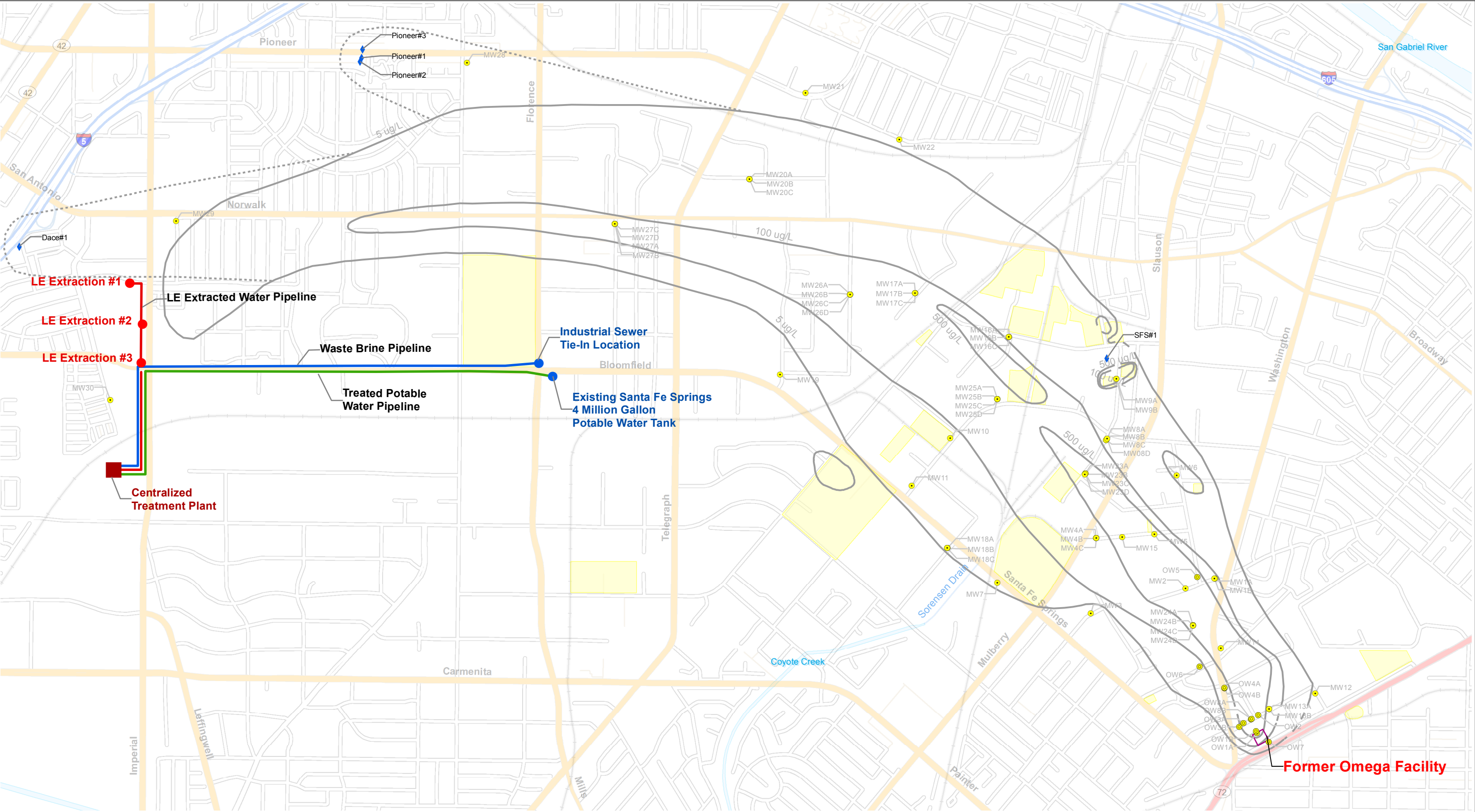


FIGURE 3-2 (SHEET 2 OF 2)  
 ALTERNATIVE 2 - LEADING EDGE EXTRACTION WITH DRINKING WATER END USE  
 SIMPLIFIED PROCESS FLOW DIAGRAM





**Legend**

- EPA Monitoring Well
- Omega Potentially Responsible Parties Organized Group(OPOG) Monitoring Well
- ◆ Active production Wells
- Extraction Wells
- Tie-In Locations

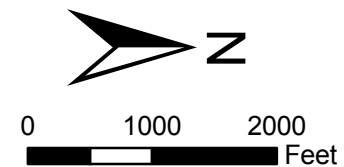
- Groundwater Treatment Plant
- Approximate Boundary of Facilities
- Former Omega Facility

**Preliminary Pipelines**

- Extracted Water Pipeline
- Treated Potable Water Pipeline
- Waste Brine Pipeline

— PCE Plume Contour Line (Third Quarter 2007)

— Potential deep (up to approximately 200 feet below ground surface) PCE extent



**Figure 3-3**  
**Alternative 2 Proposed Locations of**  
**Extraction Wells, Pipelines, and Treatment Plant**  
Omega OU2 Feasibility Study



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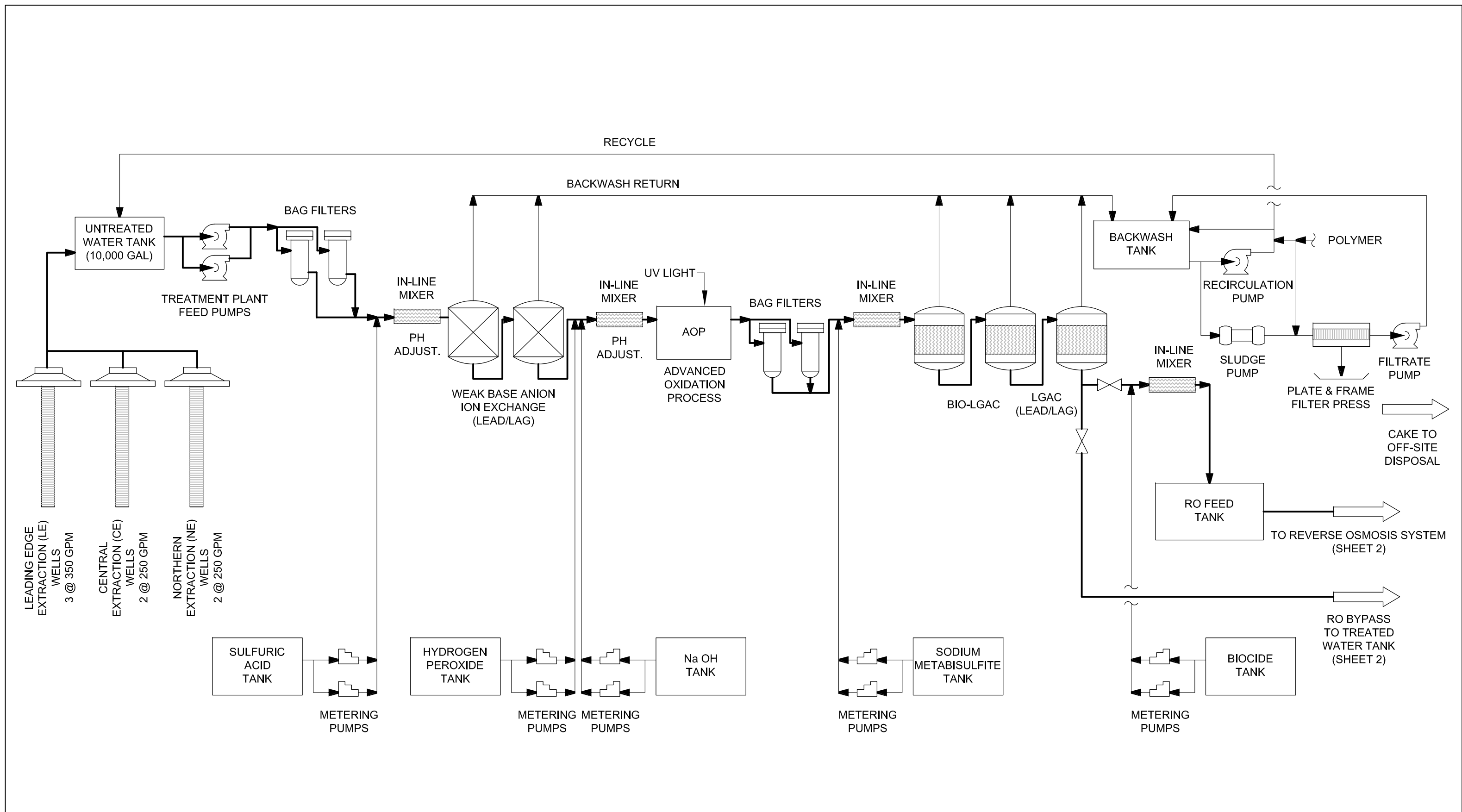


FIGURE 3-4 (SHEET 1 OF 2)  
 ALTERNATIVE 3 - PLUME WIDE EXTRACTION WITH RECLAIMED WATER END USE  
 SIMPLIFIED PROCESS FLOW DIAGRAM



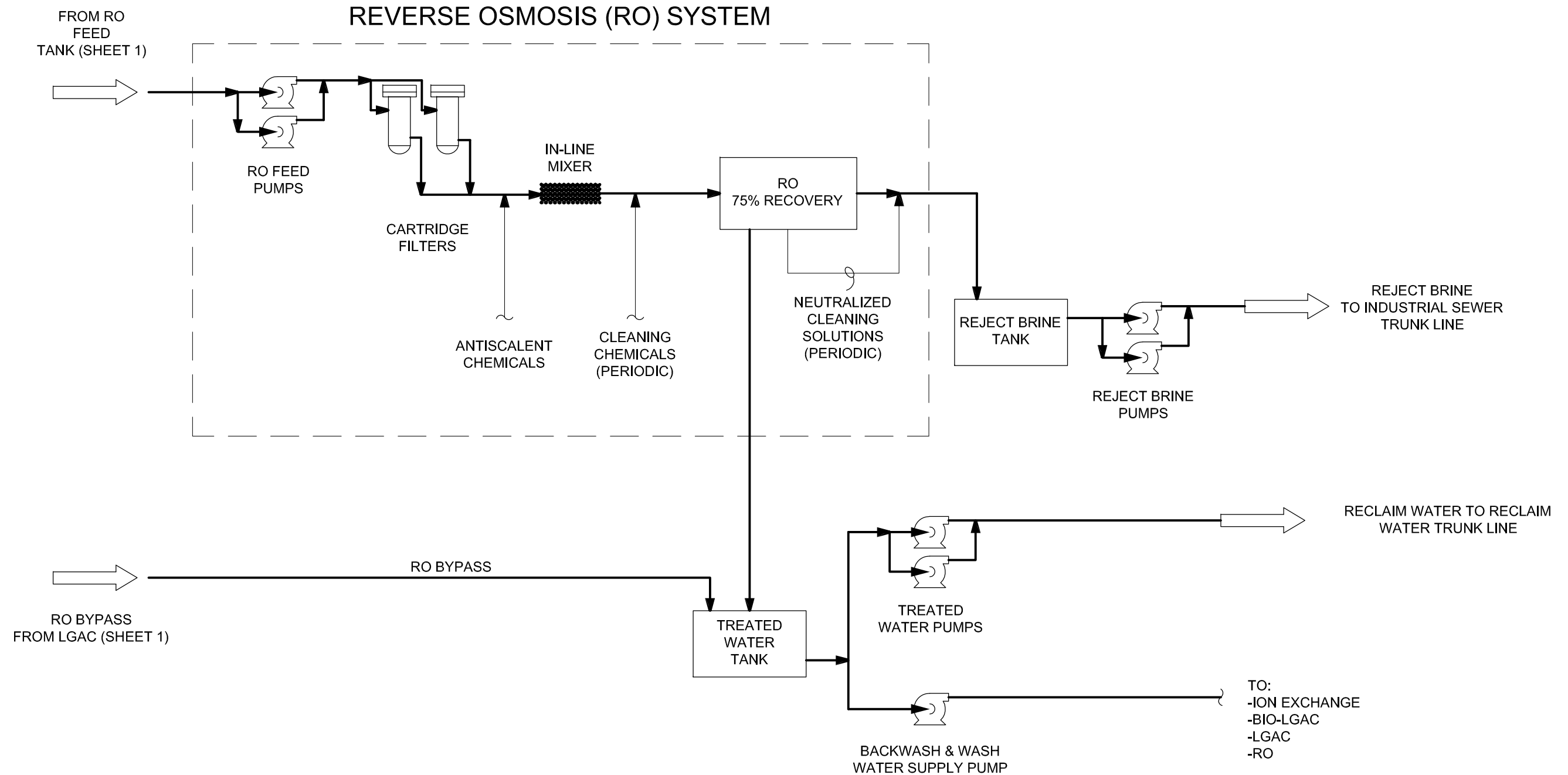
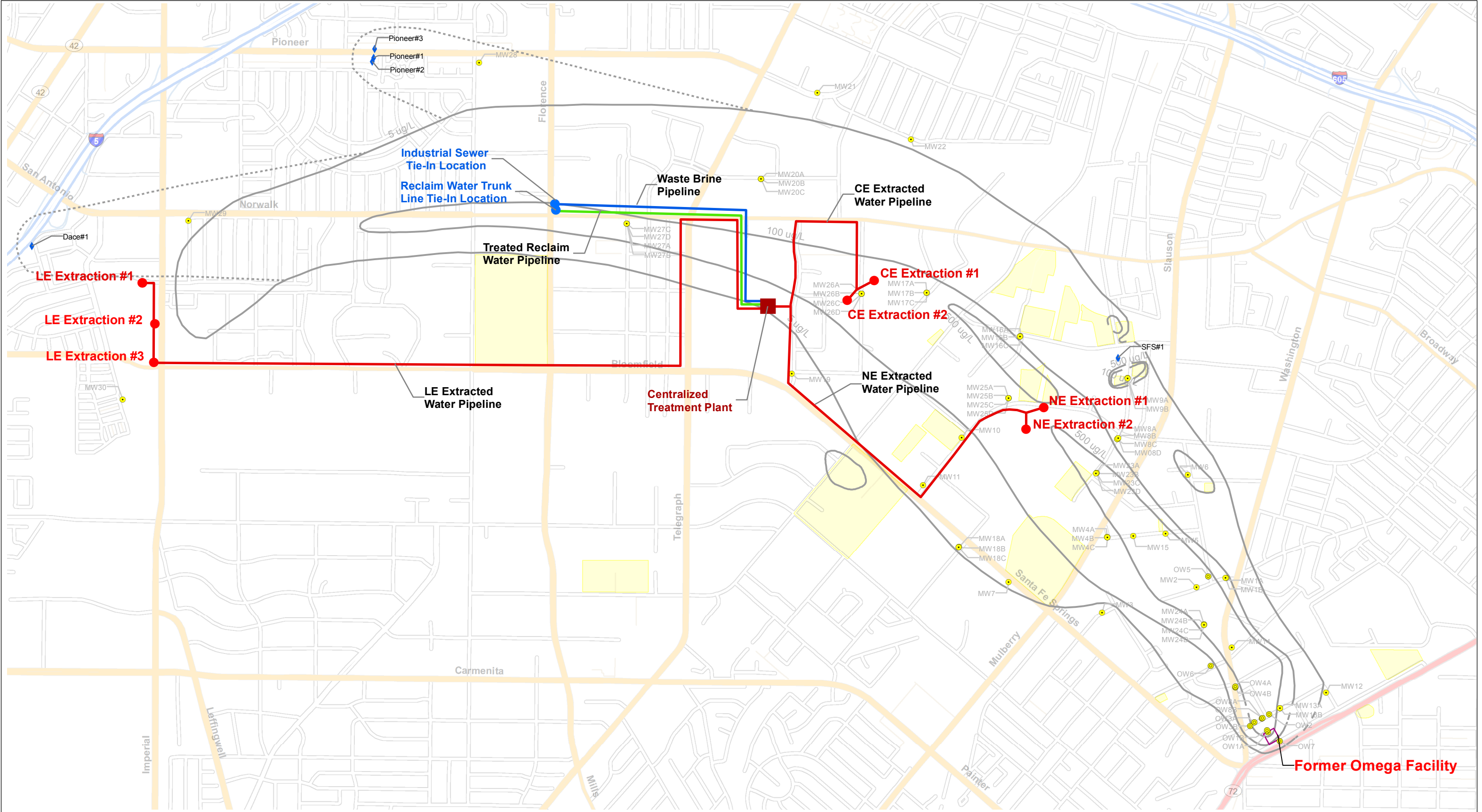


FIGURE 3-4 (SHEET 2 OF 2)  
 ALTERNATIVE 3 - PLUME WIDE EXTRACTION WITH RECLAIMED WATER END USE  
 SIMPLIFIED PROCESS FLOW DIAGRAM





**Legend**

- EPA Monitoring Well
- Omega Potentially Responsible Parties Organized Group(OPOG) Monitoring Well
- ◆ Active production Wells
- Extraction Wells
- Tie-In Locations

- Groundwater Treatment Plant
- Approximate Boundary of Facilities
- Former Omega Facility

**Preliminary Pipelines**

- Extracted Water Pipeline
- Treated Reclaim Water Pipeline
- Waste Brine Pipeline

— PCE Plume Contour Line (Third Quarter 2007)

— Potential deep (up to approximately 200 feet below ground surface) PCE extent



0 1000 2000 Feet

**Figure 3-5**  
**Alternative 3 Proposed Locations of**  
**Extraction Wells, Pipelines, and Treatment Plant**  
Omega OU2 Feasibility Study



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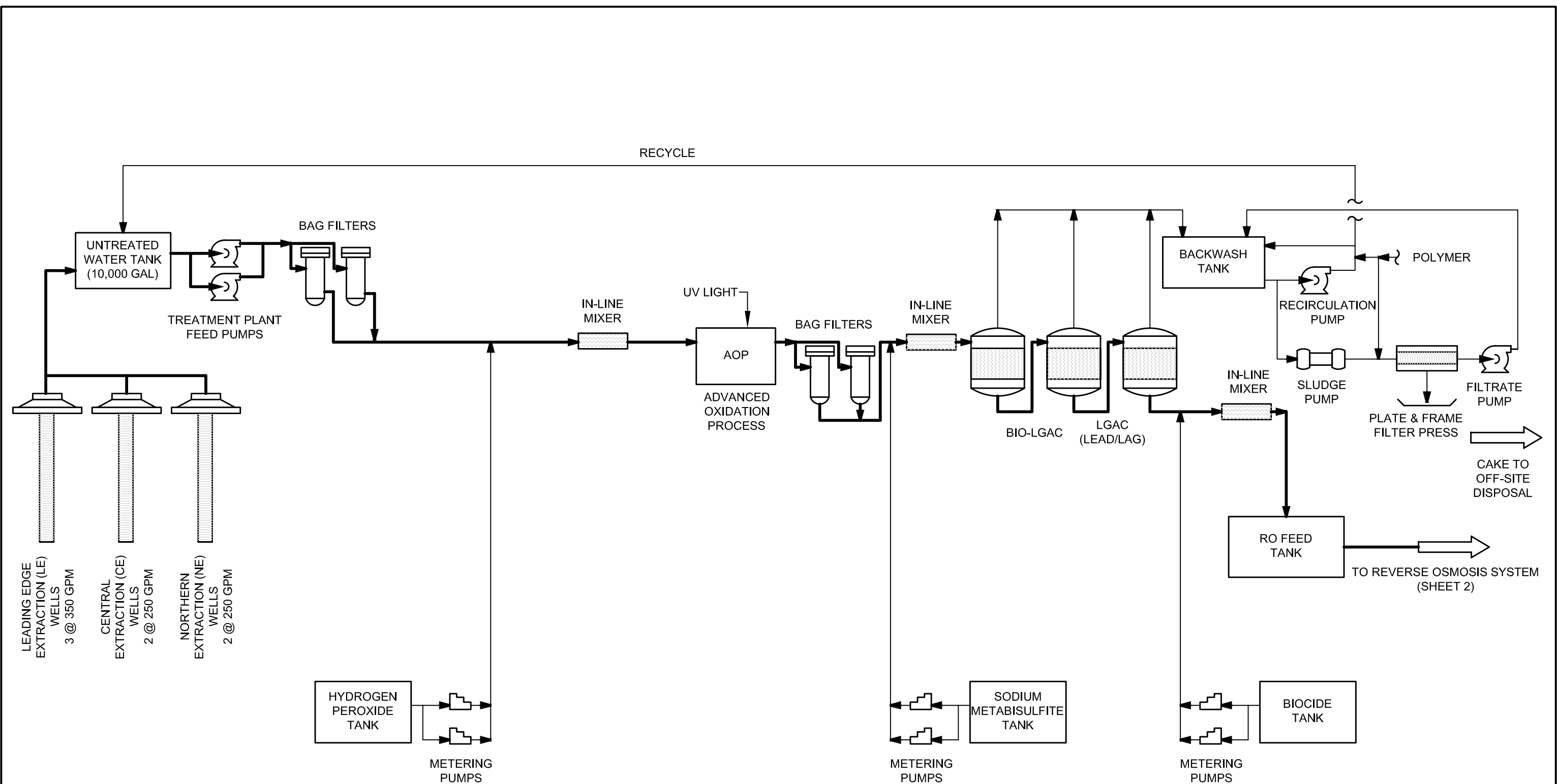
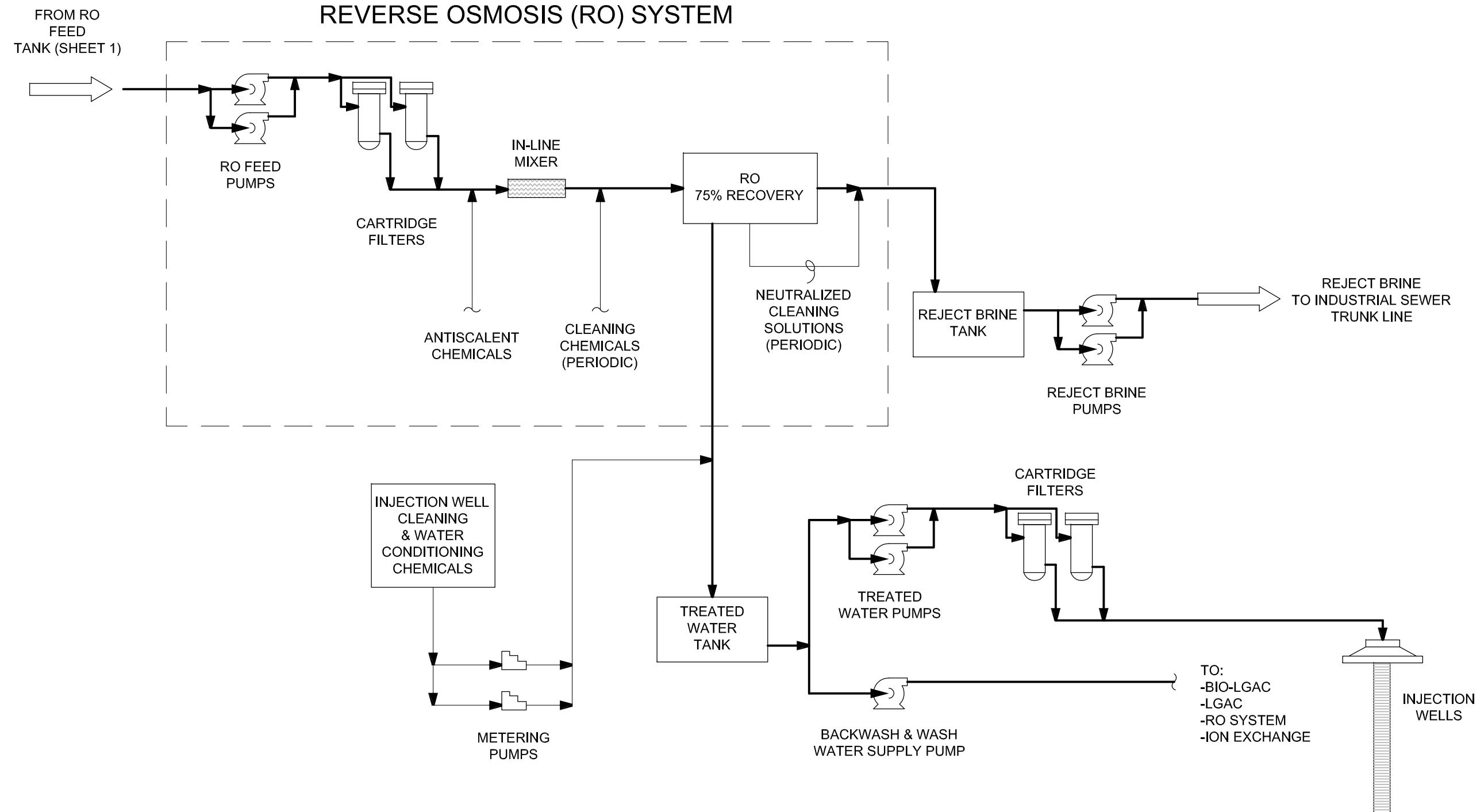


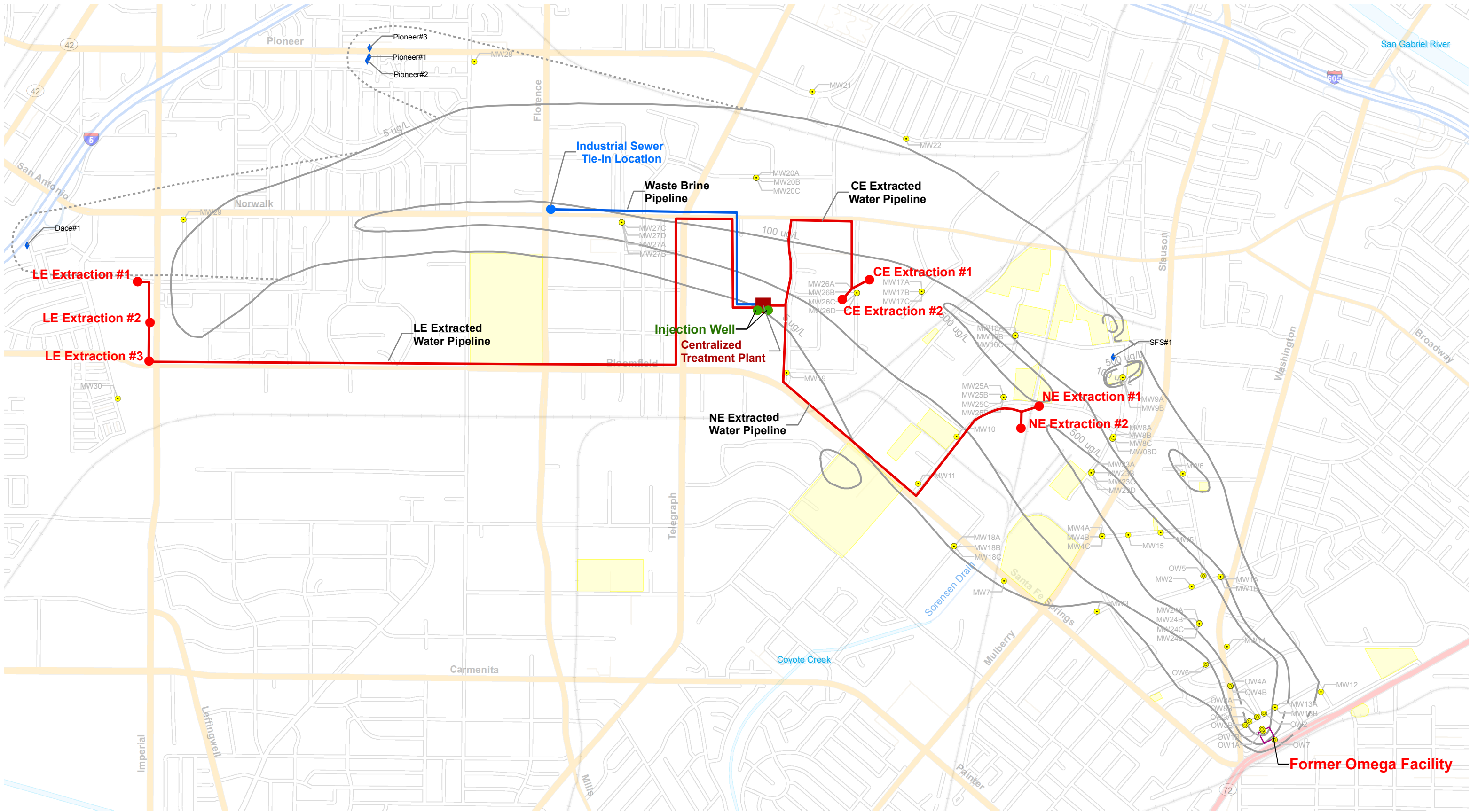
FIGURE 3-6 (SHEET 1 OF 2)  
 ALTERNATIVE 4 - PLUME WIDE EXTRACTION WITH REINJECTION  
 SIMPLIFIED PROCESS FLOW DIAGRAM





**FIGURE 3-6 (SHEET 2 OF 2)**  
**ALTERNATIVE 4 - PLUME WIDE EXTRACTION WITH REINJECTION**  
**SIMPLIFIED PROCESS FLOW DIAGRAM**





●

EPA Monitoring Well

●

Omega Potentially Responsible Parties  
Organized Group(OPOG) Monitoring Well

◆

Active production Wells

●

Extraction Wells

●

Injection Wells

●

Tie-In Locations

■

Groundwater  
Treatment Plant

■

Approximate Boundary  
of Facilities

□

Former Omega Facility

—

Extracted Water Pipeline

—

Waste Brine Pipeline

—

PCE Plume Contour Line  
(Third Quarter 2007)

—

Potential deep (up to approximately  
200 feet below ground surface) PCE extent

0

1000

2000

Feet

0

1000

2000

Feet

Figure 3-7

Alternative 4 Proposed Locations of  
Extraction Wells, Pipelines, and Treatment Plant

Omega OU2 Feasibility Study

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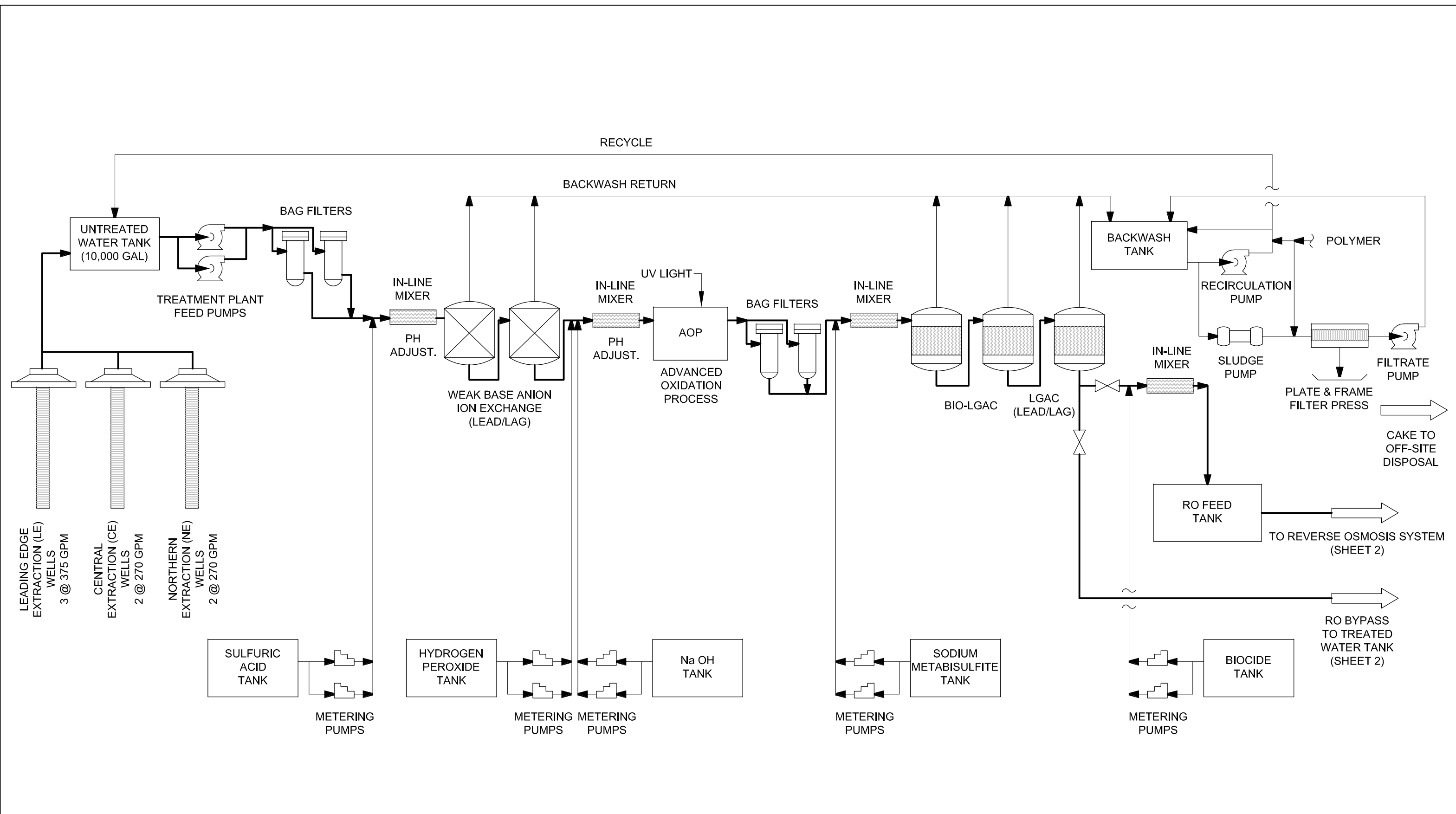


FIGURE 3-8 (SHEET 1 OF 2)  
 ALTERNATIVE 5 - PLUME WIDE EXTRACTION WITH DISCHARGE TO SPREADING BASINS  
 SIMPLIFIED PROCESS FLOW DIAGRAM



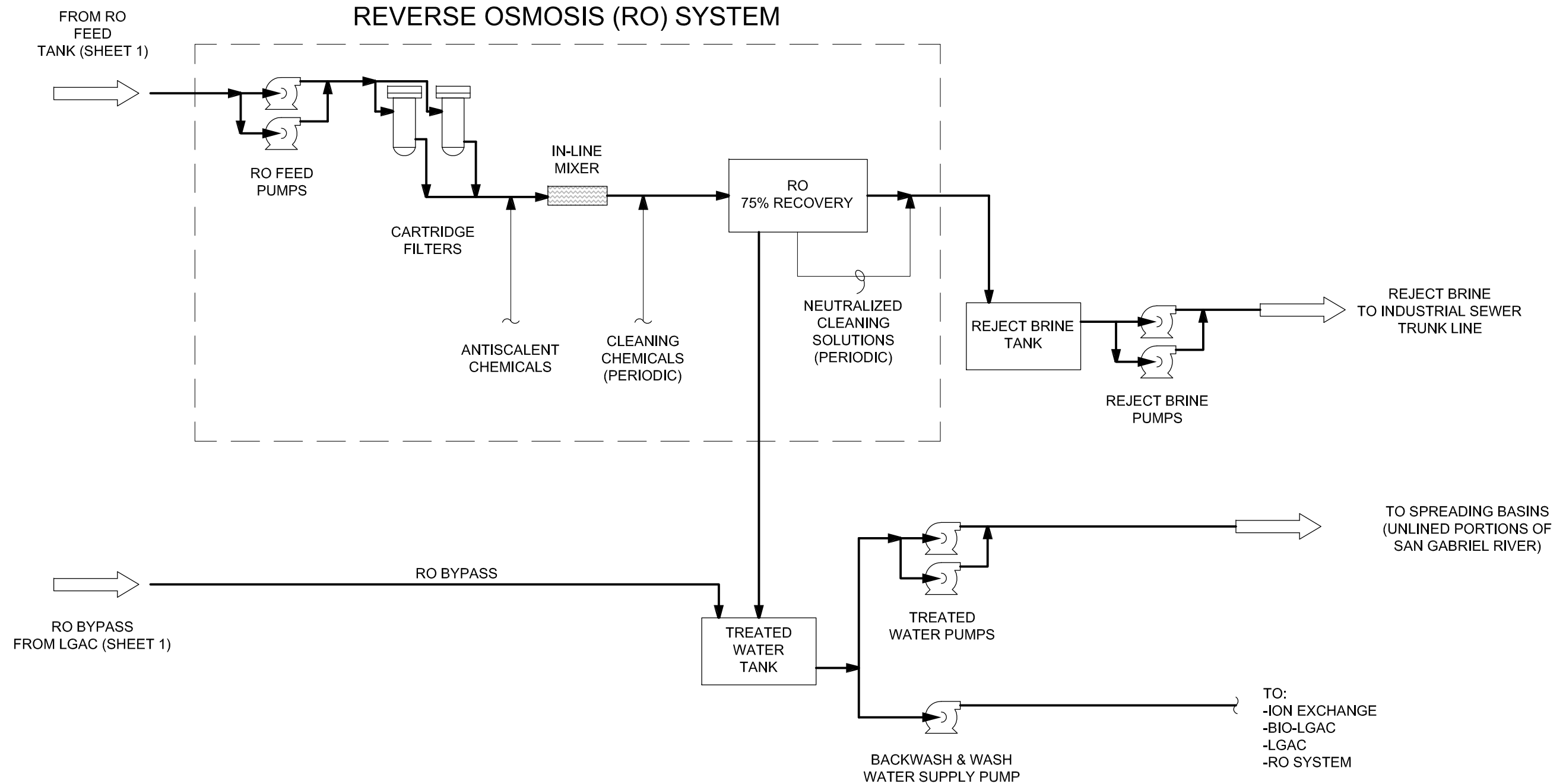
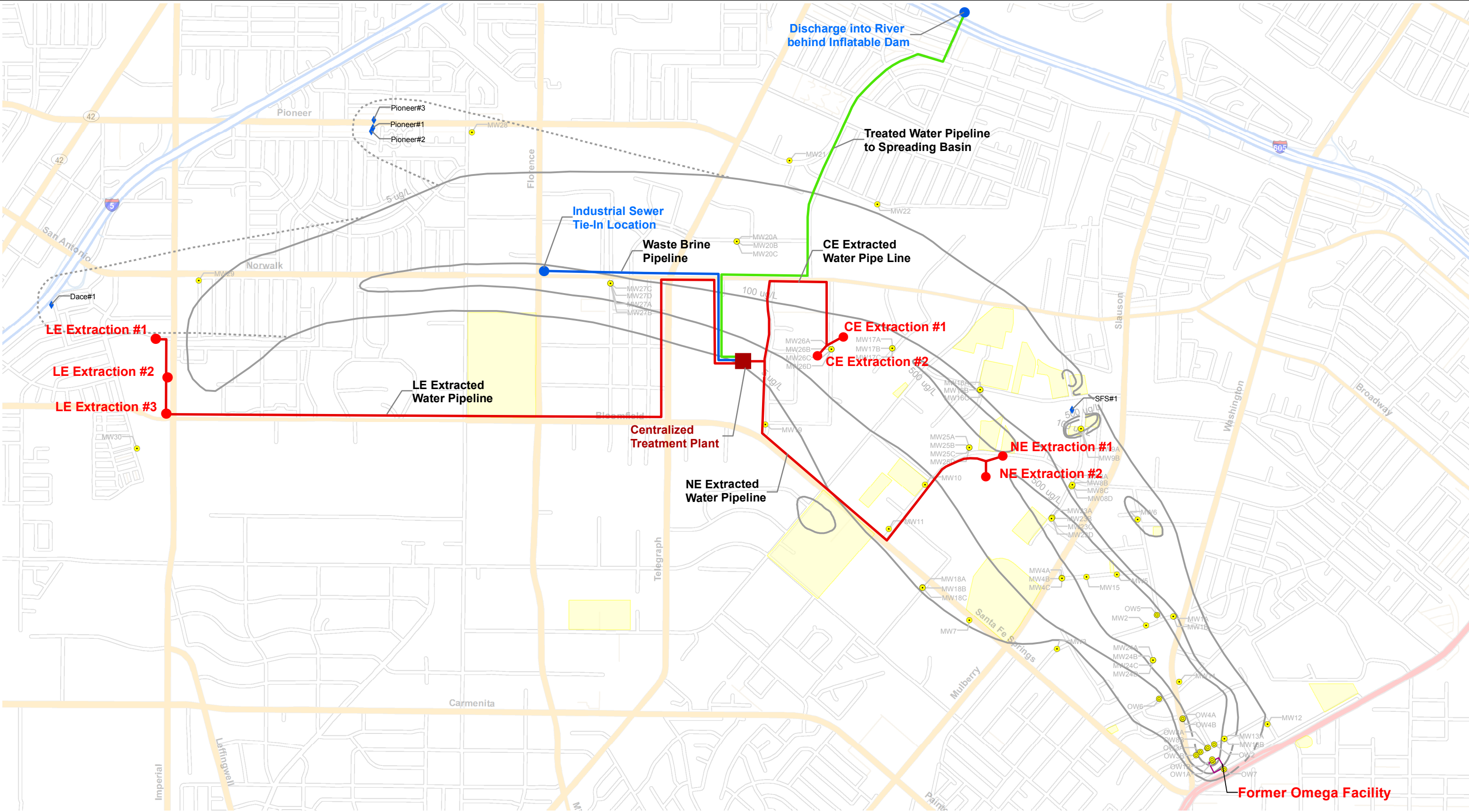


FIGURE 3-8 (SHEET 2 OF 2)  
 ALTERNATIVE 5 - PLUME WIDE EXTRACTION WITH DISCHARGE TO SPREADING BASINS  
 SIMPLIFIED PROCESS FLOW DIAGRAM





**Legend**

- EPA Monitoring Well
- Omega Potentially Responsible Parties Organized Group(OPOG) Monitoring Well
- Active production Wells
- Extraction Wells
- Tie-In Locations

Groundwater Treatment Plant

Approximate Boundary of Facilities

Former Omega Facility

**Preliminary Pipelines**

- Extracted Water Pipeline
- Treated Spreading Basin Water Pipeline
- Waste Brine Pipeline

PCE Plume Contour Line (Third Quarter 2007)

Potential deep (up to approximately 200 feet below ground surface) PCE extent


0

1000

2000

Feet

**Figure 3-9**  
**Alternative 5 Proposed Locations of Extraction Wells, Pipelines, and Treatment Plant**  
Omega OU2 Feasibility Study



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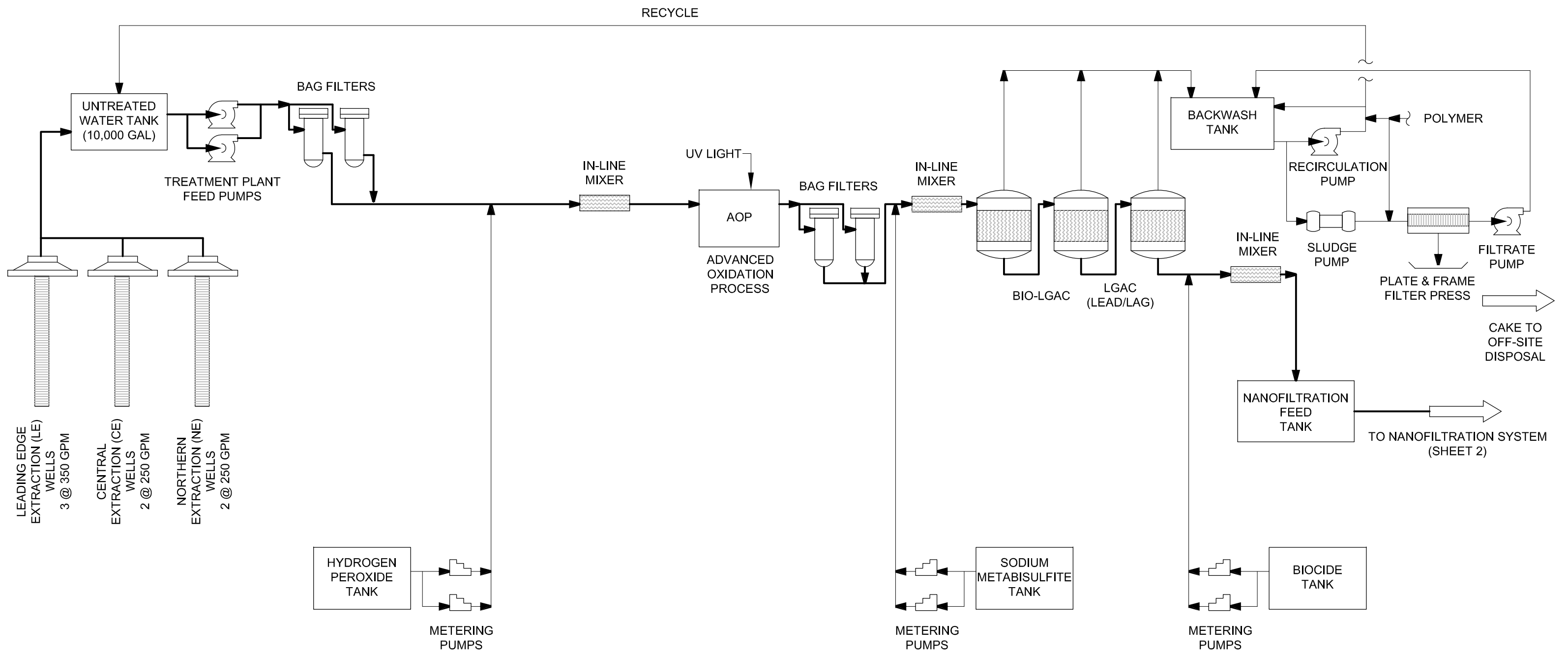


FIGURE 3-10 (SHEET 1 OF 2)  
 ALTERNATIVE 6 - PLUME WIDE EXTRACTION WITH DRINKING WATER END USE  
 SIMPLIFIED PROCESS FLOW DIAGRAM



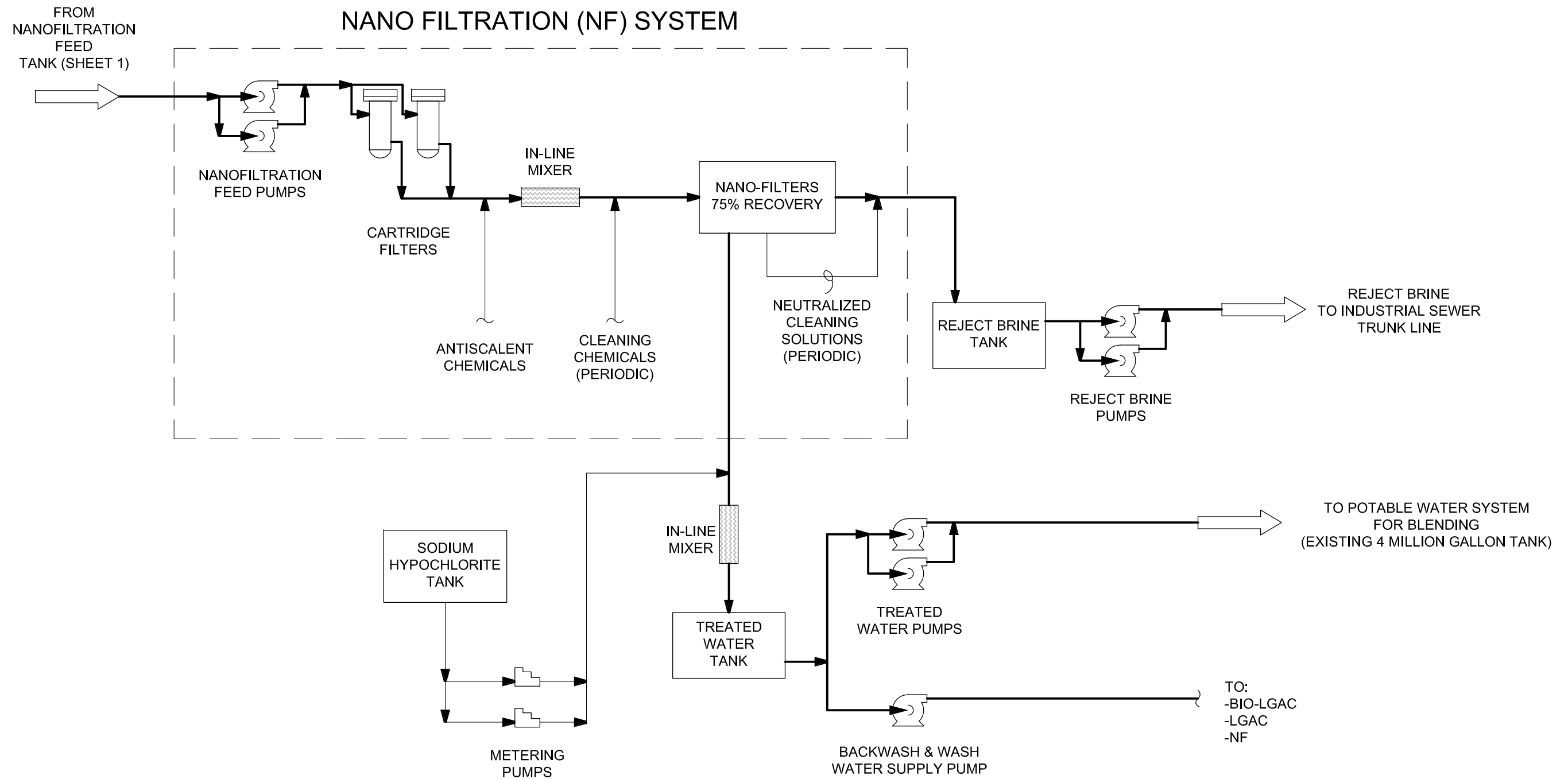


FIGURE 3-10 (SHEET 2 OF 2)  
 ALTERNATIVE 6 - PLUME WIDE EXTRACTION WITH DRINKING WATER END USE  
 SIMPLIFIED PROCESS FLOW DIAGRAM







## 4. Detailed Analysis of Remedial Alternatives

---

### 4.1 Introduction

This section provides a detailed analysis of remedial alternatives developed for OU2 groundwater at the Omega Site. The remedial alternatives described in Section 3 are evaluated against the first seven of the nine criteria specified in EPA guidance (EPA, 1988) and against the *Draft Framework for Green Cleanup Standards at Contaminated Sites* (EPA, 2009). The alternatives are first evaluated individually against each criterion, and then are compared to evaluate the relative performance of each alternative in relation to each of the criteria.

#### 4.1.1 NCP Criteria

The NCP (40 CFR 300.430[e][9][iii]) identifies nine criteria for evaluating remedial alternatives and categorizes them into the following three groups:

- Threshold Criteria
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Primary Balancing Criteria
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume through treatment
  - Short-term effectiveness
  - Implementability
  - Cost
- Modifying Criteria
  - State acceptance
  - Community acceptance

Each category of criteria has its own weight when it is evaluated. Threshold criteria are requirements that an alternative must meet to be eligible for selection as the preferred alternative, and include overall protection of human health and the environment and compliance with ARARs (unless a waiver is obtained).

Primary balancing criteria are used to weigh effectiveness and cost tradeoffs among alternatives. The primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The primary balancing criteria represent the main technical criteria upon which the alternatives evaluation is based.

Modifying criteria include state and community acceptance and may be used to modify aspects of the preferred alternative when preparing the ROD. Modifying criteria are generally evaluated after public comment on the RI/FS and the proposed plan. Accordingly,

only the two threshold and five primary balancing criteria are considered in the detailed analysis phase. The following sections contain descriptions of the first seven evaluation criteria, individual evaluations of the alternatives, and comparative evaluation for all alternatives.

### 4.1.2 Principles for Green Remediation

An environmental footprint impact assessment was conducted for each remedial alternative. In August 2009, the EPA Office of Solid Waste and Emergency Response (OSWER) issued a new policy to evaluate cleanup actions comprehensively to ensure that protection of human health and the environment occurs and to reduce the environmental footprint of cleanup activities, to the maximum extent possible, through considering *Principles for Green Remediation*. In considering these principles, OSWER cleanup programs will ensure that the cleanups and subsequent environmental footprint reduction occur in a manner consistent with the statutes and regulations governing EPA cleanup programs and without compromising cleanup objectives, community interests, the reasonableness of cleanup timeframes, or the protectiveness of the cleanup actions.

### 4.1.3 Description of Evaluation Criteria

The considerations evaluated during the analysis of each alternative per each criterion are summarized in Table 4-1.

#### 4.1.3.1 Overall Protection of Human Health and the Environment

This criterion assesses whether each alternative provides and maintains adequate protection of human health and the environment. Alternatives are assessed to determine whether they can adequately protect human health and the environment from unacceptable risks posed by contaminants present in OU2 groundwater, in both the short and long term. This criterion is also used to evaluate how risks would be eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

#### 4.1.3.2 Compliance with ARARs

This criterion is used to determine if each alternative would comply with ARARs under federal environmental laws and state environmental or facility siting laws, or whether invoking waivers to specific ARARs is justified. Other information identified as TBC criteria, such as advisories, criteria, or guidance, is considered where appropriate during the ARARs analysis. Potential action-, location-, and chemical-specific ARARs for the alternatives presented in this FS are identified in Section 2.

#### 4.1.3.3 Long-Term Effectiveness and Permanence

This criterion addresses the ability of an alternative to maintain reliable protection of human health and the environment over time once clean-up objectives have been achieved. The primary components of this criterion are the magnitude of residual risk remaining at Omega OU2 after remedial objectives have been met and the extent and effectiveness of controls that might be required to manage the risk posed by treatment residuals and untreated wastes.

#### 4.1.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the degree to which alternatives employ treatment or recycling technologies that permanently and significantly reduce the toxicity, mobility, or volume, of hazardous materials in the extracted water at Omega OU2.

The NCP expresses EPA's preference for remedies where treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.

#### 4.1.3.5 Short-Term Effectiveness

This criterion considers the effect of each alternative on the protection of the community, workers and the environment during the construction and implementation process. The short-term effectiveness evaluation only addresses protection prior to meeting the RAOs.

#### 4.1.3.6 Implementability

This criterion evaluates the technical feasibility and administrative feasibility (i.e., the ease or difficulty) of implementing each alternative and the availability of required services and materials during its implementation.

#### 4.1.3.7 Cost

This criterion evaluates the cost of implementing each alternative. The cost of an alternative encompasses all engineering, construction, and O&M costs incurred over the life of the project. This includes both short-term capital costs and long-term O&M costs. According to CERCLA guidance, cost estimates for remedial alternatives are to be developed with an expected accuracy range of -30 to +50 percent.

The costs of the remedial alternatives are compared using the estimated net present value (NPV) of the alternative. The NPV allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. For estimating NPV, a 30-year period of operation has been assumed. O&M for the remedial alternatives may extend beyond 30 years.

For all alternatives, the NPV was calculated using the real discount rate provided by the *Office of Management and Budget Circular A-94*. The real discount rate based on the economic assumptions from the 2004 budget for programs with durations of 30 years or longer is 7 percent.

The capital costs, annual O&M costs, and 30-year NPV for each of the alternatives are summarized in Table 4-2. Detailed cost estimates and cost estimate assumptions are provided in Appendix B.

### 4.1.4 Green Cleanup Assessment

In addition to the seven NCP criteria, each alternative is also evaluated using the concept of sustainability by estimating its consumption and reuse of raw materials (including treated groundwater and wastewater), energy consumption, and greenhouse gas (GHG) emissions associated with different treatment technologies. This assessment evaluates the degree to which the remedial alternative can be viewed as "green" from the perspective of improving

environmental conditions. However, the use of energy, materials, and resources for the cleanup activities creates its own environmental footprint. The assessment and optimization of the cleanup to minimize its environmental impact is referred to as “green cleanup assessment.”

The new OSWER policy (August 27, 2009) cites the following five elements of a green cleanup assessment that are assessed for each alternative:

- Total Energy Use and Renewable Energy Use
- Air Pollutants and Greenhouse Gas Emissions
- Water Use and Impacts to Water Resources
- Material Management and Waste Reduction
- Land Management and Ecosystems Protection

Because the action alternatives use similar technologies, the green assessment focused on the relative comparison of the environmental impacts between the alternatives. Each alternative was assigned an “environmental score” ranging from one to three, with three representing the best possible ranking (i.e., the lowest environmental footprint or impact). A detailed description of the methodology used for the green assessment is provided in Appendix C. The results are summarized in the comparative analysis of alternatives listed in Section 4.2.

The green cleanup assessment will be revisited at the RD phase and green remediation principles will be integrated into the design and operation of the groundwater pumping and treatment system once an interim remedy is selected. The environmental footprint assessment of each alternative is preliminary during the FS and development of remedial alternatives. During the RD phase, the environmental footprint of the selected remedy should be reduced to the maximum extent practicable to ensure that protection of human health and the environment occurs. Detailed engineering studies will be conducted to optimize pipeline routing and design, for example, not just to reduce the initial cost of pipeline installation, but to account for energy usage (pumping power costs) associated with different pipeline materials (e.g., use smaller versus larger pipe sizes; use of smoother pipeline materials to reduce pressure losses, etc.). The design would include consideration of extensive use of lower energy consuming equipment such as variable frequency motors with high efficiencies, as well as solar panels to produce onsite power to offset facility power requirements from the local power supplier. In addition, consideration will be given to procurement of electrical power from greener source suppliers. Emerging technologies and changes in the economic environment at the time of remedial design effort will also be considered in order to minimize the environmental footprint of the selected remedy.

## 4.2 Individual Analysis of Remedial Alternatives

In this section, each alternative is evaluated with respect to the threshold and primary NCP criteria.

### 4.2.1 Alternative 1 – No Action

The No Action Alternative provides a baseline for comparing other alternatives. Because no remedial activities would be implemented under this alternative, long-term human health risks for OU2 would be essentially the same as those identified in the HHRA.

**Overall protection of human health and the environment** – Alternative 1 would provide no protection of human health and the environment associated with exposure to contaminated groundwater other than what might be achieved through current and potential future source control actions at individual facilities under state lead. However, these current and future source control measures are not expected to address overall OU2 plume capture. Under this alternative, the contamination in OU2 groundwater would migrate into portions of the regional aquifer that are currently clean or contain only low concentrations of contaminants. The contaminant plume would also migrate toward production wells and into areas beyond the current boundaries of the OU2 plume. Wellhead treatment systems currently in place at some impacted production wells may not be able to adequately remove all contaminants that would be present as the OU2 plume continues to migrate. As such, Alternative 1 would not achieve overall protection of human health and the environment.

**Compliance with ARARs** – In the context of an interim containment remedy, and because no action is being taken, there are no chemical-specific ARARs (such as the MCLs for drinking water) identified for Alternative 1. Similarly, no location-specific and no action-specific ARARs exist for Alternative 1.

**Long-term effectiveness and permanence** – Alternative 1 would allow uninhibited migration of the contaminants in groundwater, with long-term impacts to the regional drinking water aquifer and production wells. All current and potential future risks to human health associated with exposure to contaminated groundwater would remain.

**Reduction of toxicity, mobility, or volume through treatment** – The No Action Alternative would achieve no reduction of toxicity, mobility, or volume through treatment.

**Short-term effectiveness** – There would be no short-term impacts to human health or the environment as a result of this alternative being implemented.

**Implementability** – The No Action Alternative is implementable by definition.

**Cost** – The present value cost of Alternative 1 is zero (\$0).

**Green Assessment** – This type of evaluation does not apply to a No Action Alternative because no actions will be implemented.

### 4.2.2 Alternative 2 – Leading Edge Extraction with Drinking Water End Use

Alternative 2 would achieve capture of the OU2 plume through extraction wells located at the LE area of the plume. The groundwater would be treated to meet drinking water standards and provided to a local water purveyor. Waste brine from the treatment plant would be discharged to an industrial sewer. This alternative includes ICs and groundwater monitoring using both new and existing monitoring wells.

Alternative 2 would require the installation of three extraction wells. In addition, 24 new monitoring wells; a centralized GWTP; and conveyance pipelines for extracted groundwater, treated water, and waste brine would be constructed. The total length of installed pipelines would be about 22,400 feet.

**Overall protection of human health and the environment** – Extraction at the LE area only may not achieve vertical containment of the plume because downward hydraulic gradients exist throughout OU2. This alternative may not achieve complete lateral containment if groundwater flow conditions change in the future due to, for example, changes in production pumping in this area. Also, it will not inhibit migration of groundwater with high concentrations of COCs into zones with currently lower concentrations of COCs (RAO3). The contaminant concentrations reaching the four GSWC wells are expected to increase during the initial years of implementation of Alternative 2. The suite of contaminants reaching these wells may also change. As a result, existing wellhead treatment systems may require treatment modifications in order to continue meeting drinking water standards. The production wells and their wellhead treatment systems are not part of the alternative; any required modifications would be implemented by the water purveyors.

Although this alternative would permanently remove contamination from the extracted groundwater, it does not achieve protection because it is predicted to achieve less than adequate vertical (as well as lateral) capture of the contaminated groundwater.

The alternative includes recovery and reuse of about 75 percent of total extracted water, with the remaining 25 percent being discharged as waste brine. This type of water reuse would contribute to water conservation efforts and alleviate the impacts of the drought conditions in the region.

**Compliance with ARARs** – Alternative 2 would meet all chemical-, location-, and action-specific ARARs for an interim action containment remedy. Drinking water would be treated to meet or exceed MCLs and TBC criteria, such as NLs.

**Long-term effectiveness and permanence** – Alternative 2 may not achieve complete vertical containment because downward hydraulic gradients exist throughout OU2. It may not achieve complete lateral containment if groundwater flow conditions change in the future; for example, in response to changes in the allocation of water production in the basin. Also, it will not inhibit migration of groundwater with high concentrations of COCs into zones with currently lower concentrations of COCs. The impacted production wells (SFS #1 and four GSWC wells) are expected to continue capturing a portion of the contamination and would require continued wellhead treatment. The OU2 plume is expected to initially increase in size and then decrease, with the extent of the decrease in plume size dependent on the timing and scope of source control measures at sources of contamination within OU2.

Influent concentrations at the LE extraction wells are expected to increase over the 30-year remedy timeframe. As extraction begins at the LE, influent concentrations are expected to be ND as currently seen at nearby MW30. During the 30-year operational period, the influent COC concentrations are expected to increase, possibly reaching concentrations similar to current MW26 concentrations as shown in Table 3-2.

The treatment processes would permanently remove the contaminants from the extracted groundwater.

The alternative assumes continuing operation of the existing, impacted production wells. Should production from these wells decrease or stop, the remedy will actually perform better because plume capture can be achieved with lower extraction rates if the four GSWC production wells do not operate or operate at lower pumping rates. However, increased pumping from the production wells would negatively impact the remedy; higher pumping rates, increased treatment, conveyance, and discharge capacities, and potentially also additional extraction wells, could be necessary to prevent increased plume capture by the production wells.

**Reduction of toxicity, mobility, or volume through treatment** – The treatment provided under Alternative 2 will reduce toxicity, mobility, and volume of contaminants from the extracted groundwater. Treatment is expected to not only remove COCs such as VOCs, 1,4-dioxane, and total chromium to below MCLs and NLs, it will also generally improve the existing shallow groundwater quality by further reducing specific contaminants that are below MCLs and NLs to even lower levels. These would include COCs such as metals removed by NF and various VOCs removed by AOP, Bio-LGAC, and LGAC.

VOCs removed by LGAC from the extracted groundwater are destroyed when the LGAC is thermally regenerated offsite. Some VOCs are also destroyed by the AOP treatment itself. TDS and metals, including total chromium, are removed from the main extracted water volume by the NF process to reduce its toxicity; however, these constituents are concentrated into a smaller waste brine stream that is sent to the sewer and eventually get discharged to the ocean via a POTW ocean outfall.

**Short-term effectiveness** – All construction activities would take place in (mainly industrially) developed areas with minimal expected impacts to the environment. Noise and dust abatement during the construction and management and offsite disposal of the contaminated drill cuttings and purge water would be required to protect the community during the remedy implementation. Standard Occupational Safety and Health Administration (OSHA) requirements would be protective of workers during the construction. It is expected that the remedy would be constructed within 1 year.

**Implementability** – Alternative 2 is based on proven technologies for both construction and operation. It is expected that all construction would be performed in compliance with all substantive requirements of federal, state, and local permits applicable to this project. The effectiveness of the treatment would be monitored by direct effluent sampling and analysis. The effectiveness of the capture would be monitored indirectly using existing and new groundwater monitoring wells, groundwater flow modeling, or other methods. The remedy could be modified, if necessary, to accommodate higher flow rates, additional extraction wells, or a different method of treatment.

Alternative 2 could meet federal, state, and local permitting requirements. Water rights would have to be purchased, leased, or an agreement would have to be developed with one or more purveyors that would be recipients of the potable water to use their water rights. The potable water would be subject to a replenishment assessment. The waste brine discharge portion of the extracted water would require an NWU Permit and would qualify for a replenishment assessment exemption.

Treatment of groundwater from an impaired source for potable use would require preparation of a CDPH 97-005 permit application and implementation of its requirements, including extensive monitoring and testing provisions.

The NF reject waste brine would be discharged to a nearby LACSD industrial sewer line. Although, by the LACSD Wastewater Ordinance, Section 305 policy, LACSD restricts the discharge of groundwater into its POTW system; it is likely that the agency would accept this wastewater because it would be wastewater generated as part of a water reuse effort rather than direct groundwater discharge. Section 305 of LACSD's Wastewater Ordinance allows for case-by-case exceptions to this policy if other alternatives are technically or economically infeasible.

**Cost** – The capital and annual O&M costs for Alternative 2 would be \$29.2 million and \$2.0 million, respectively (Table 4-2). The corresponding NPV is \$53.6 million. It should be noted that LACSD sewer connection fees and annual surcharges are a significant part of the initial capital cost and NPV. The cost estimates exclude the replenishment assessment based on the assumption that the water purveyors receiving the potable water would pay the replenishment assessment as they normally would when extracting water using their own water rights.

**Green Cleanup Assessment** – This alternative has an environmental score of 1.8. The low footprint in terms of air pollution and GHG emissions, materials management and waste reduction, and land management and ecosystems contributed most to the scoring. These high scores were somewhat offset by a low score on water resources because about 25 percent of the extracted water constitutes waste brine that has no beneficial use. A more detailed green cleanup assessment is provided in Appendix C.

### 4.2.3 Alternative 3 – Plumewide Extraction with Reclaimed Water End Use

Alternative 3 would achieve capture of the OU2 plume through extraction wells located at the LE, CE, and NE (i.e., throughout the plume). The cyclical demand for reclaimed water would negatively impact plume capture efficiency because extraction rates would have to be reduced significantly, and potentially for prolonged periods of time, when demand is low. The groundwater would be treated to meet reclaimed water standards and discharged to an existing reclaimed water line. Waste brine from the treatment plant would be discharged to an industrial sewer. This alternative includes institutional controls and groundwater monitoring using both new and existing monitoring wells.

Alternative 3 would require the installation of seven extraction wells; 40 new monitoring wells; a centralized GWTP; and conveyance pipelines for extracted groundwater, treated water, and waste brine. The total length of installed pipelines would be about 38,700 feet.

**Overall protection of human health and the environment** – Alternative 3 would achieve capture through extraction along the longitudinal axis of the plume. Extraction at locations distributed along the plume will increase confidence in achieving and maintaining containment. Multiple wells allow the extraction rates to be varied throughout the plume in response to changing groundwater flow conditions. Extraction wells at multiple locations within the plume can also prevent downward contaminant migration from the shallow zone into the deeper aquifer units, which are used for drinking water production.

In addition, the CE and NE extraction well locations will prevent the spread of highly contaminated groundwater into areas of lesser contamination. This alternative also achieves a high degree of contaminant mass removal because extraction wells at both the CE and NE areas will capture groundwater with higher contaminant concentrations than extraction wells near the plume's leading edge. The impacted production wells (SFS1 and four GSWC wells) will require continued wellhead treatment because these wells will continue to extract contaminated groundwater. The concentrations reaching the GSWC wells are expected to temporarily increase during the initial years of operation.

The existing wellhead treatment systems at production wells currently use LGAC for VOC treatment. It is possible that these treatment systems may need to be augmented with additional treatment processes such as AOP or RO for other COCs in the future. The production wells and their wellhead treatment systems are not part of the alternative; any required modifications would be implemented by the water purveyors.

This alternative would permanently remove contamination from the extracted groundwater. This alternative would achieve overall protection of human health and environment as long as there is sufficient year-round demand for the reclaimed water; otherwise, it would not.

The alternative includes recovery and reuse of about 88 percent of the total extracted water, with about the remaining 12 percent discharged as waste brine. This type of water reuse would contribute to water conservation efforts and help alleviate the impacts of the drought conditions in the region.

**Compliance with ARARs** – Alternative 3 would meet all chemical-, location-, and action-specific ARARs, as well as the TBC criterion of 11 µg/L for Cr+6 for situations where irrigation runoff from reclaimed water use flows into storm drains and subsequently into surface water, such as the San Gabriel River.

**Long-term effectiveness and permanence** – Alternative 3 would achieve capture of the OU2 plume, although the five production wells are expected to continue capturing a portion of the contamination. The extraction and treatment system in this alternative would permanently remove the contaminants from the groundwater.

The downgradient portion of the OU2 plume is expected to initially increase in size and then decrease. The extent of the overall decrease in plume size would depend on the timing and scope of source control measures at sources of contamination within OU2.

Currently, the demand for reclaimed water is much lower than available supply, and LACSD has excess reclaimed water available that it discharges to the ocean. However, demand is expected to increase in the future as CBMWD and City of Industry expand their reclaim distribution systems. In the short term, for the option to be viable, LACSD would have to cut back on the amount of reclaimed water it sends to the CBMWD reclaim distribution system so that OU2 treated water could be preferentially used, until overall reclaimed water requirements increase over the coming years.

The long-term effectiveness of this alternative would be diminished because the treated water production would exceed demand for reclaimed water at different times of the year, and during times of low demand, the remedy wells would not operate at the required capacity and would not achieve plume capture. The highest demand is in the summer

season, and the lowest demand is in the winter season. This cyclical demand would negatively impact plume capture efficiency because extraction rates would have to be reduced significantly for prolonged periods of time. Use of reclaimed water, therefore, may not be a viable stand-alone end use option.

The alternative assumes continuous operation of the existing, impacted production wells. Should production from these wells decrease or stop, the remedy will actually perform better because plume capture can be achieved with lower extraction rates if the four GSWC production wells and SFS1 do not operate or operate at reduced pumping rates. Substantially increased pumping from the production wells could negatively impact the remedy; higher pumping rates, increased treatment, conveyance, and discharge capacities, and potentially also additional extraction wells, could be necessary to prevent increased plume capture by the production wells.

**Reduction of toxicity, mobility, or volume through treatment** – The treatment provided under Alternative 3 will remove the contaminants from the extracted groundwater. Treatment options are expected to remove SVOCs, VOCs, 1,4-dioxane, AOP byproducts, selenium, Cr+6, TDS, and metals. The treated effluent concentrations would be below MCLs. Although Alternative 3 includes plumewide extraction, its degree of COC reductions would be adversely impacted if there are prolonged periods of little or no extraction due to low seasonal demands for reclaimed water.

VOCs removed by LGAC from the extracted groundwater are destroyed when the LGAC is thermally regenerated offsite. Some VOCs are also destroyed by the AOP unit itself. Cr+6 removed by IX is typically precipitated out as an inert solid during offsite IX regeneration. Other metals and TDS are removed from the extracted groundwater by the RO process; however, these constituents are concentrated into a smaller waste brine stream that is sent to the sewer and eventually get discharged to the ocean via a POTW ocean outfall.

**Short-term effectiveness** – All construction activities would take place at developed areas with minimal expected impacts to the environment. Noise and dust abatement during the construction and management and offsite disposal of the contaminated drill cuttings and purge water would be required to protect the community during the remedy implementation. Standard OSHA requirements would be protective of workers during the construction. It is expected that the remedy would be constructed within 1 year of remedial design approval.

**Implementability** – Alternative 3 is based on proven technologies for both construction and operation. It is expected that all construction would be performed in compliance with all substantive federal, state, and local permits applicable to this project. The effectiveness of the treatment would be monitored by direct effluent sampling and analysis. The effectiveness of the capture would be monitored indirectly using groundwater monitoring wells, groundwater flow modeling, or other methods. The remedy could be modified, if necessary, to accommodate higher flow rates, additional extraction wells, or a different method of treatment to account for changes in COCs.

Alternative 3 can meet federal, state, and local permitting requirements. Water rights would have to be purchased, leased, or an agreement would have to be developed with one or more purveyors that would be recipients of the treated water to use their water rights. The

reclaimed water would be subject to a replenishment assessment. The waste brine discharge portion of the extracted water would require an NWU Permit and would qualify for a replenishment assessment exemption.

The NF reject waste brine will be discharged to a nearby LACSD industrial sewer line. Although, by policy, LACSD does not want to accept groundwater into its POTW system, it is very likely that the agency would accept this wastewater because it is wastewater generated as part of a water reuse effort associated with groundwater cleanup.

Overall, use of OU2 system effluent as reclaimed water in the short term does not save water in the region; it would result in the LACSD discharging a commensurate amount of potential reclaimed water to the ocean that OU2 would be supplying. During the RD phase, agreements and policies between CBMWD and LACSD would have to be reviewed to see if replacement of a portion of LACSD's reclaimed water supply to CBMWD with OU2 reclaimed water supply is viable.

Water rights will likely be an issue for this end use option. The WRD encourages the remediation of contaminated water and typically provides a basin replenishment assessment exemption for nonconsumptive use. However, because usage of reclaimed water is a consumptive use, this exemption would not be allowed for the portion of the water that is used as reclaimed water. The waste brine that is discharged to the sewer would likely be eligible for a replenishment assessment exemption.

**Cost** – The capital and annual O&M costs for Alternative 3 would be \$40.1 million and \$3.7 million, respectively. The corresponding NPV is \$86.6 million (Table 4-2). These costs are based on a replenishment assessment of \$205 per acre-foot and are subject to change if the unit replenishment assessment cost continues to increase over the years.

**Green Cleanup Assessment** – Alternative 3 received a total environmental score of 1.3. The scoring was mainly affected by its relatively high footprint in the categories of air pollution and GHG emissions, materials management and waste reduction, and land management and ecosystems. This alternative scored High on water resources because only about 12 percent of the extracted water constitutes waste brine that has no beneficial use. However, the beneficial use of the treated water under this alternative would be offset by discharges to the ocean of reclaimed water from other treatment facilities in the basin due to the limited demand for reclaimed water. So although this alternative scores High in the category of water resources, its actual contribution to water resource conservation in the basin would be none. Should the scoring account for the increased ocean discharge from LACSD to offset the reclaimed water provided by the remedy Alternative 3 would score 1.0 on the water use and water resource categories, and its overall score would be 1.1. A more detailed green cleanup assessment is provided in Appendix C.

#### 4.2.4 Alternative 4 – Plumewide Extraction with Reinjection

Alternative 4 would achieve capture of the OU2 plume through extraction wells located at the LE, CE, and NE (i.e., throughout the plume). The groundwater would be treated to meet basin standards and re-injected to the deep aquifer. Waste brine from the treatment plant would be discharged to an industrial sewer. This alternative includes ICs and groundwater monitoring using both new and existing monitoring wells.

Alternative 4 would require the installation of seven extraction wells, two injection wells, and forty monitoring wells, and the construction of a centralized treatment plant and conveyance pipelines for extracted water, treated water, and waste reject brine. The total length of installed pipelines would be about 33,200 feet.

**Overall protection of human health and the environment** – Alternative 4 would permanently remove contamination from the extracted groundwater. It would achieve capture through extraction along the longitudinal axis of the plume in the same manner as Alternative 3. The impacted production wells (SFS1 and four GSWC wells) would require continued wellhead treatment if they continued extracting contaminated groundwater. The contaminant concentrations reaching the GSWC wells are expected to temporarily increase during the initial years of operation.

The existing wellhead treatment systems at production wells currently use LGAC for VOC treatment. It is possible that these treatment systems may need to be augmented with additional treatment processes such as AOP or RO for of other COCs in the future. The production wells and their wellhead treatment systems are not part of the alternative; any required modifications would be implemented by the water purveyors.

This alternative would permanently remove contamination from the extracted groundwater and would achieve overall protection of human health and environment.

The alternative includes recovery and reinjection of about 75 percent of total extracted water, with the remaining 25 percent to be discharged as waste brine. Overall, water reuse in this manner would contribute to water conservation efforts and to alleviating the impacts of the drought conditions in the region.

**Compliance with ARARs** – Alternative 4 would meet all chemical-, location-, and action-specific ARARs.

**Long-term effectiveness and permanence** – Alternative 4 would achieve capture of the plume, although the five production wells are expected to continue capturing a portion of the contamination. As extraction begins, influent concentrations are expected to be equivalent to MW27, MW23, and MW26 at LE, CE, and NE extraction areas, respectively. Influent concentrations are expected to decrease over time as the contaminated groundwater is removed. The treatment would permanently remove the contaminants from the groundwater.

The downgradient portion of the OU2 plume is expected to initially increase in size and then decrease. The overall decrease in plume size would depend on the timing and scope of source control measures at sources of contamination within OU2.

The alternative assumes continuous operation of the existing, impacted production wells. Should production from these wells decrease or stop, the remedy will actually perform better (i.e., plume capture can be achieved with lower extraction rates if the three GSWC production wells and SFS1 do not operate or operate at lower pumping rates). Substantially increased pumping from the production rates would negatively impact the remedy; higher pumping rates, increased treatment, conveyance, and discharge capacities, and potentially also additional extraction wells would be necessary to prevent increased plume capture by the production wells.

**Reduction of toxicity, mobility, or volume through treatment** – The treatment provided under Alternative 4 will remove the contaminants from the extracted groundwater. The treatment process will reduce concentrations of the COCs in the extracted water to concentrations that are the same or lower than those present in the deep aquifer. In addition, all the contaminants identified in Table 5-5 of the Summary of OU2 Detections in the RI report (CH2M HILL, 2010), other than those that currently exist in the deep aquifer, will be treated to ND levels so as not to degrade the water quality in the aquifer.

VOCs removed by LGAC from the extracted groundwater are destroyed when the LGAC is thermally regenerated offsite. Some VOCs are also destroyed by the AOP unit itself. Metals, including total chromium as well as TDS are removed from the extracted groundwater volume by the RO process; however, these COCs are concentrated into a smaller waste brine stream that is sent to the sewer and eventually get discharged to the ocean via a POTW ocean outfall.

**Short-term effectiveness** – All construction activities would take place at developed areas with no expected impacts to the environment. Noise and dust abatement during the construction and management and offsite disposal of the contaminated drill cuttings and purge water would be required to protect the community during the remedy implementation. Standard OSHA requirements would be protective of workers during the construction. It is expected that the remedy would be constructed within 1 year of RD approval.

**Implementability** – Alternative 4 is based on proven technologies for both construction and operation. It is expected that all construction would be performed in compliance with all substantive federal, state, and local permits applicable to this project. The effectiveness of the treatment would be monitored by direct effluent sampling and analysis. The effectiveness of the capture would be monitored indirectly using groundwater monitoring wells, groundwater flow modeling, or other methods. The remedy could be modified, if necessary, to accommodate higher flow rates, additional extraction wells, or a different method of treatment. Additional treatment or conditioning of the extracted water may be required to prevent mineral precipitation in the zone of injection.

Alternative 4 can meet federal, state, and local permitting requirements. Water rights can be addressed by applying for and obtaining an NWU Permit for the entire extracted volume because the use is not consumptive. Both the reinjected water and the waste brine discharge from the treatment plant would qualify for a replenishment assessment exemption.

Reinjection of treated water back into the same nondrinking water aquifer from which the contaminated water has been extracted has been implemented in California. However, reinjection of treated water into a different drinking water aquifer as proposed in Alternative 4 is not widely practiced in the state. Furthermore, the RWQCB practice has been to require treatment of injection water containing COCs not already present in drinking aquifers to below laboratory detection limits. To determine the level of treatment required, a comprehensive analysis of both groundwater being extracted for treatment and existing water in the deep aquifer based on analytical methods using the lowest detection and reporting limits achievable by EPA published methods would need to be performed. The treatment system chosen may have to be refined (e.g., an additional RO stage, or higher-powered AOP, etc.) to treat COCs that may become emergent COCs in the future

(e.g., oxidation byproducts, COCs detected in the future by use of more advanced analytical methods with lower detection limits, etc.).

Overall, this alternative would likely be very difficult to implement from a regulatory approval perspective.

**Cost** – The capital and annual O&M costs for Alternative 4 would be \$41.4 million and \$2.6 million, respectively. The corresponding NPV is \$73.2 million (Table 4-2).

**Green Cleanup Assessment** – This alternative has an environmental score of 1.4. The low footprint in terms of air pollution and GHG emissions, materials management and waste reduction, and land management and ecosystems contributed most to the high scoring. These high scores were somewhat offset by a low score on water resources because about 25 percent of the extracted water constitutes waste brine with no beneficial use. A more detailed green cleanup assessment is provided in Appendix C.

#### 4.2.5 Alternative 5 – Plumewide Extraction with Discharge to Spreading Basins

Alternative 5 would achieve capture of the OU2 plume through extraction wells located at the LE, CE, and NE (i.e., throughout the plume). The groundwater would be treated to meet replenishment water standards and discharged to the spreading basins. Waste brine from the treatment plant would be discharged to an industrial sewer. This alternative includes ICs and groundwater monitoring using both new and existing monitoring wells.

Alternative 5 would require the installation/construction of seven extraction wells; forty monitoring wells; a centralized plant; and conveyance pipelines for extracted water, treated water, and waste reject brine. The total length of installed pipelines would be about 41,900 feet.

**Overall protection of human health and the environment** – Alternative 5 would permanently remove contamination from the extracted groundwater. It would achieve capture of the OU2 plume in the same manner as Alternatives 3 and 4. The impacted production wells (SFS1 and four GSWC wells) will require continued wellhead treatment because these wells will continue extracting contaminated groundwater. The contaminant concentrations reaching the GSWC wells are expected to increase over time.

The existing wellhead treatment systems at production wells currently use LGAC for VOC treatment. It is possible that these treatment systems may need to be augmented with additional treatment processes such as AOP or RO for of other COCs in the future. The production wells and their wellhead treatment systems are not part of the alternative; any required modifications would be implemented by the water purveyors.

This alternative would permanently remove contamination from the extracted groundwater and would achieve overall protection of human health and environment.

The alternative includes recovery and reuse of about 88 percent of total extracted water, with the remaining 12 percent to be discharged as waste brine. The water routed into the spreading basins would infiltrate into the subsurface and recharge the deep drinking water aquifers of the Central Basin. Overall, water reuse in this manner would contribute to water conservation efforts and to alleviating the impacts of the drought conditions in the region.

**Compliance with ARARs** – Alternative 5 would meet all chemical-, location-, and action-specific ARARs. In addition, the alternative will achieve the TBC criterion of 11 µg/L for Cr+6 in treated water that is discharged into the infiltration basins and subsequently into surface waters, such as the San Gabriel River.

**Long-term effectiveness and permanence** – Alternative 5 would provide capture of the plume, although the five production wells are expected to continue capturing a portion of the contamination. As extraction begins, influent concentrations are expected to be equivalent to MW27, MW23, and MW26 at LE, CE, and NE extraction areas, respectively. Influent concentrations are expected to decrease over time as the contaminated groundwater is removed. The treatment would permanently remove the contaminants from the groundwater.

The downgradient portion of the OU2 plume is expected to initially increase in size and then decrease. The overall decrease in plume size would depend on the timing and scope of source control measures at sources of contamination within OU2.

The alternative assumes continuous operation of the existing, impacted production wells. Should production from these wells decrease or stop, the remedy will actually perform better (plume capture can be achieved with lower extraction rates if the three GSWC production wells and SFS1 do not operate or operate at lower pumping rates). Substantially increased pumping from the production rates would negatively impact the remedy; higher pumping rates, increased treatment, conveyance, and discharge capacities, and potentially also additional extraction wells would be necessary to prevent increased plume capture by the production wells.

**Reduction of toxicity, mobility, or volume through treatment** – The treatment provided under Alternative 5 will remove the contaminants from the extracted groundwater. Treatment options are expected to remove SVOCs, VOCs, 1,4-dioxane, AOP byproducts, selenium, Cr+6, TDS, and metals consistent with NPDES requirements and TBCs.

VOCs removed by LGAC from the extracted groundwater are destroyed when the LGAC is thermally regenerated offsite. Some VOCs are also destroyed by the AOP unit itself. TDS and metals, such as total chromium and selenium, are removed from the extracted groundwater by the RO process; however, these constituents are concentrated into a smaller waste brine stream that is sent to the sewer and eventually get discharged to the ocean via a POTW ocean outfall.

**Short-term effectiveness** – All construction activities would take place at developed areas with no expected impacts to the environment. Noise and dust abatement during the construction and management and offsite disposal of the contaminated drill cuttings and purge water would be required to protect the community during the remedy implementation. Standard OSHA requirements would be protective of workers during the construction. It is expected that the remedy would be constructed within 1 year of RD approval.

**Implementability** – Alternative 5 is based on proven technologies for both construction and operation. It is expected that all construction would be performed in compliance with all substantive federal, state, and local permits applicable to this project. The effectiveness of the treatment would be monitored by direct effluent sampling and analysis. The effectiveness of the capture would be monitored indirectly using groundwater monitoring

wells, groundwater flow modeling, or other methods. The remedy could be modified, if necessary, to accommodate higher flow rates, additional extraction wells, or a different method of treatment.

Alternative 5 can meet federal, state, and local permitting requirements. Water rights can be addressed by applying for and obtaining an NWU Permit for the entire extracted volume because the use is not consumptive. Both the water sent to spreading basins and the waste brine discharge from the treatment plant would qualify for a replenishment assessment exemption.

Implementability may be hampered by the regulatory review and approval process. Numerous local and state agencies are involved in the design and operation of the spreading basins, which are operated under the jurisdiction of Los Angeles County. These agencies include WRD, DWR, RWQCB, Metropolitan Water District of Southern California (MWD), CBMWD, California Department of Fish and Game (CDFG), LACSD, Los Angeles County Department of Public Works (LACDPW), various other water purveyors, and CDPH potentially in an advisory role.

From an overall regional water reuse perspective, Alternative 5 would benefit regional water reuse programs. Other than natural water flows, one of the major sources of water used in the regional spreading basin is reclaimed municipal wastewater from the San Jose Creek WRP, which is owned and operated by LACSD. Alternative 5 would allow LACSD to add more water for infiltration purposes, resulting in a net positive amount of reuse of water from LACSD that would normally be discharged to the ocean. This is because LACSD is currently limited in the amount of municipal wastewater-derived reclamation water that can be used for infiltration in the spreading basins. This limitation is based on specific ratios of natural water to reclamation water that cannot be exceeded as specified by state water board mandates, as a means to maintain the water quality in the aquifer. One positive aspect of discharge to spreading basins is that the OU2 treated water is not viewed as a municipal source and would be considered “dilution water.” Discharge of OU2 treated “dilution water” would allow LACSD to send more reclamation water to the spreading basins (instead of to the ocean), while still complying with established natural dilution water to reclamation water ratios. Overall, this would benefit regional water reuse efforts.

**Cost** – The capital and annual O&M costs for Alternative 5 would be \$41.6 million and \$3.3 million, respectively. The corresponding NPV is \$82.9 million (Table 4-2).

**Green Cleanup Assessment** – Alternative 5 has a total relative environmental score of 1.3. The low scoring is attributed to its relatively high footprint in the categories of air pollution and GHG emissions, materials management and waste reduction, and land management and ecosystems. This alternative scored High on water resources because only about 12 percent of the extracted water constitutes waste brine that has no beneficial use. A more detailed green cleanup assessment is provided in Appendix C.

#### 4.2.6 Alternative 6 – Plumewide Extraction with Drinking Water End Use

Alternative 6 would achieve capture of the OU2 plume through extraction wells located at the LE, CE, and NE (i.e., throughout the plume). The groundwater would be treated to meet drinking water standards and supplied to an existing drinking water system. Waste brine

from the treatment plant would be discharged to an industrial sewer. This alternative includes ICs and groundwater monitoring using both new and existing monitoring wells.

Alternative 6 would require the installation/construction of seven extraction wells; 40 monitoring wells; a centralized plant; and conveyance pipelines for extracted water, treated water, and waste reject brine. The total length of installed pipelines would be about 40,700 feet.

**Overall protection of human health and the environment** – Alternative 6 would permanently remove contamination from the extracted groundwater. It would achieve capture of the OU2 plume in the same manner as Alternatives 3, 4, and 5. The impacted production wells (SFS1 and four GSWC wells) will require continued wellhead treatment because these wells will continue extracting contaminated groundwater. The contaminant concentrations reaching the GSWC wells are expected to increase over time.

The existing wellhead treatment systems at production wells currently use LGAC for VOC treatment. It is possible that these treatment systems may need to be augmented with additional treatment processes such as AOP or RO for other COCs in the future. The production wells and their wellhead treatment systems are not part of the alternative; any required modifications would be implemented by the water purveyors.

This alternative would permanently remove contamination from the extracted groundwater and would achieve overall protection of human health and environment.

The alternative includes recovery and reuse of about 75 percent of total extracted water, with the remaining 25 percent to be discharged as waste brine. This type of water reuse would contribute to water conservation efforts and to alleviating the impacts of the drought conditions in the region.

**Compliance with ARARs** – Alternative 6 would meet all chemical-, location-, and action-specific ARARs. Drinking water would be treated to meet or exceed MCLs and NLs.

**Long-term effectiveness and permanence** – Alternative 6 would provide capture of the plume, although the five production wells are expected to continue capturing a portion of the contamination. As extraction begins, influent concentrations are expected to be equivalent to MW27, MW23, and MW26 at LE, CE, and NE extraction areas, respectively. Influent concentrations are expected to decrease over time as the contaminated groundwater is removed. The treatment would permanently remove the contaminants from the groundwater.

The downgradient portion of the OU2 plume is expected to initially increase in size and then decrease. The overall decrease in plume size would depend on the timing and scope of source control measures at sources of contamination within OU2.

The remedy would need to account for the operation of the impacted production wells. Should production from these wells decrease or stop, the remedy will actually perform better (i.e., plume capture can be achieved with lower extraction rates if the three GSWC production wells and SFS1 do not operate or operate at lower pumping rates). Substantially increased pumping from the production rates would negatively impact the remedy; higher pumping rates, increased treatment, conveyance, and discharge capacities, and potentially also additional extraction wells would be necessary.

**Reduction of toxicity, mobility, or volume through treatment** – The treatment provided under Alternative 6 will remove the contaminants from the extracted groundwater. Treatment options are expected to remove SVOCs, VOCs, 1,4-dioxane, AOP byproducts, selenium, TDS, sulfate, and metals consistent with drinking water requirements and TBCs.

VOCs removed by LGAC from the extracted groundwater are destroyed when the LGAC is thermally regenerated offsite. Some VOCs are also destroyed by the AOP unit itself. Cr+6 removed by IX is typically precipitated out as an inert solid during offsite IX regeneration. Other metals and TDS are removed from the extracted groundwater by the NF process; however, these constituents are concentrated into a smaller waste brine stream that is sent to the sewer and eventually get discharged to the ocean via a POTW ocean outfall.

**Short-term effectiveness** – All construction activities would take place at developed areas with no expected impacts to the environment. Noise and dust abatement during the construction and management and offsite disposal of the contaminated drill cuttings and purge water would be required to protect the community during the remedy implementation. Standard OSHA requirements would be protective of workers during the construction. It is expected that the remedy would be constructed within 1 year of RD approval.

**Implementability** – Alternative 6 is based on proven technologies for both construction and operation. It is expected that all construction would be performed in compliance with all substantive federal, state, and local permits applicable to this project. The effectiveness of the treatment would be monitored by direct effluent sampling and analysis. The effectiveness of the capture would be monitored indirectly using groundwater monitoring wells, groundwater flow modeling, or other methods. The remedy could be modified, if necessary, to accommodate higher flow rates, additional extraction wells, or a different method of treatment.

Alternative 6 can meet federal, state, and local permitting requirements. Water rights would have to be purchased, leased or an agreement would have to be developed with one or more purveyors that would be recipients of the potable water to use their water rights. The potable water would be subject to a replenishment assessment. The waste brine discharge portion of the extracted water would require an NWU Permit and would qualify for a replenishment assessment exemption.

Treatment of groundwater from an impaired source for potable use would require preparation of a CDPH 97-005 permit application and implementation of its requirements, including extensive monitoring and testing provisions.

**Cost** – The capital and annual O&M costs for Alternative 5 would be \$38.4 million and \$2.5 million, respectively. The corresponding NPV is \$69.2 million (Table 4-2). The cost estimates exclude the replenishment assessment based on the assumption that the water purveyors receiving the potable water would pay the replenishment assessment fee as they normally would when extracting water using their own water rights.

**Green Cleanup Assessment** – Alternative 6 had a total relative environmental score of 1.3. This alternative has low footprint in terms of air pollution and GHG emissions and materials management and waste reduction. These high scores were offset by low scores on water resources because about 25 percent of the extracted water constitutes waste brine that

has no beneficial use, total energy use and renewable energy, and on land management and ecosystems protection. A more detailed green cleanup assessment is provided in Appendix C.

## 4.3 Comparative Analysis of Remedial Alternatives

This section evaluates the relative performance of each alternative in relation to one another for each of the NCP's threshold and primary balancing criteria. The comparative analysis identifies the advantages and disadvantages of each alternative to assist in selection of a preferred remedial alternative. Table 4-3 presents a summary of the comparative analysis.

### 4.3.1 Overall Protection of Human Health and the Environment

Alternatives 4 through 6 achieve overall protection by containing the OU2 plume and preventing the spread of contamination to clean areas of the drinking water aquifers and to production wells outside of the OU2 plume. They would permanently remove contamination from the extracted groundwater and would allow for beneficial reuse of the treated water within the basin. Alternative 3 achieves overall protection as long as there is sufficient year round demand for the reclaimed water because cyclical demand for reclaimed water will impair plume capture efficiency; otherwise it does not achieve overall protection. Alternative 2 does not achieve overall protection because it will likely not achieve complete plume capture and thus will not protect drinking water aquifers and production wells outside OU2.

Under all the alternatives, contaminants would continue to migrate toward those production wells (SFS1 and four GSWC wells) that have already captured part of the OU2 plume (unless those wells are taken out of operation). As a result, the owners of those wells will need to continue to operate the existing wellhead treatment systems indefinitely.

Alternatives 2 and 6 would provide drinking water that meets all health-based state and federal requirements.

Alternatives 2, 3, and 6 would supply water to local delivery systems, while Alternatives 4 and 5 would replenish the deep drinking water aquifer.

Alternative 1 would not provide long-term protection of human health and environment. It would allow uninhibited migration of the contaminants in groundwater to parts of the Central Basin that contain drinking water aquifers and production wells.

Alternatives 4, 5, and 6 achieve overall protection. Alternative 3 achieves overall protection as long as there is sufficient year round demand for the reclaimed water, otherwise it does not achieve overall protection. Alternative 2 does not achieve protection because it is predicted to achieve less than adequate vertical (as well as lateral) capture of the contaminated groundwater. Alternative 1 does not achieve overall protection.

### 4.3.2 Compliance with ARARs

Alternatives 2 through 6 would meet all chemical-, location-, and action-specific ARARs for an interim action containment remedy.

The drinking water end use (Alternatives 2 and 6) are expected to trigger CDPH 97-005 requirements.

No chemical-, location-, or action-specific ARARs apply to Alternative 1.

Alternatives 2 through 6 would all equally satisfy ARARs and rank High. Alternative 1 is not ranked.

### 4.3.3 Long-Term Effectiveness and Permanence

Alternative 1 would allow uninhibited migration of the contaminants in groundwater.

Plume containment is achieved under Alternatives 2 through 6 for the protection of drinking water aquifers and downgradient production wells from future contaminant migration. Alternative 2, based on LE extraction only, may not achieve complete capture of the OU2 plume because some contamination may migrate into deeper units; lateral capture may also be compromised if groundwater conditions in the shallow aquifer change.

Alternatives 3 through 6 use plumewide extraction; they provide much higher confidence in achieving complete plume capture (with the five production wells expected to capture a portion of the contamination) than Alternative 2 and also impede the spread of contamination from high to lower concentration zones at OU2. Alternative 2 extracts groundwater at LE only; influent concentrations at the LE extraction well are expected to increase over the 30-year remedy timeframe to current MW26 concentrations. Alternatives 3 through 6 extract groundwater at LE, CE, and NE; influent concentrations are expected to decrease over time as contaminated groundwater is removed. Thus, Alternatives 3 through 6 achieve plume capture and inhibition of spreading of high-concentration zones while Alternative 2 may not achieve complete capture and allows the spreading of high-concentration zones. The five impacted production wells will capture a portion of the plume under all alternatives with the greater portion of the plume captured under Alternative 2.

Alternatives 3 through 6 rank High on long-term effectiveness. Alternative 2 ranks Medium because it would not completely satisfy RAO3 and it is less likely to achieve complete plume capture than Alternatives 3 through 6. Alternative 1 ranks Low.

### 4.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 does not provide any treatment and therefore ranks Low with respect to this criterion.

The treatment methods in Alternatives 2 through 6 will permanently remove the contaminants from the extracted groundwater. The treatment technologies used in the development of the alternatives are not tied to a specific alternative. The treated effluent concentrations are expected to be below MCLs and other applicable discharge standards.

Alternative 2 would not only remove COCs such as VOCs, SVOCs, 1,4-dioxane, and total chromium to below MCLs and NLs, it would also reduce specific contaminants that are below MCLs and NLs to even lower levels. These would include COCs such as metals removed by nanofiltration and various VOCs removed by AOP, Bio-LGAC, and LGAC. However, Alternative 2 would not capture or remove as much contamination as Alternatives 3 through 6 because Alternative 2 only extracts groundwater from the leading edge of the plume.

Alternative 3 would remove COCs such as SVOCs, VOCs, 1,4-dioxane, AOP byproducts, selenium, Cr+6, TDS, and metals. The treated effluent concentrations would meet surface water discharge requirements to allow irrigation water runoff into storm drains and nearby surface waters below MCLs. Although Alternative 3 includes plumewide extraction, it will provide the lowest degree of COC reductions of all the alternatives because of prolonged periods of little or no extraction due to low seasonal demands for reclaimed water.

Alternative 4 would reduce concentrations of COCs in the treated water that are already present in the deep aquifer to the same or lower levels. In addition, all the COCs identified in Table 5-5, Summary of OU2 Detections in the RI report (CH2M HILL, 2010), but that may not be present in the deep aquifer, will be treated to ND levels so as not to degrade the water quality in the aquifer. Until more comprehensive characterization of the deep aquifer is done at the RD phase, the treatment requirements for some or all of the COCs (Table 5-5 of the RI report) cannot be determined.

Alternative 5 would remove COCs such as SVOCs, VOCs, 1,4-dioxane, AOP byproducts, selenium, Cr+6, TDS, and metals consistent with NPDES requirements and TBCs.

Alternative 6 would remove COCs such as SVOCs, VOCs, 1,4-dioxane, AOP byproducts, selenium, Cr+6, TDS, and metals consistent with drinking water standards.

Alternative 2 ranks Medium based on this criterion because the groundwater extracted would not contain as much contamination for removal by treatment compared to the plumewide extraction scenarios. Alternative 3, which includes plumewide extraction, ranks Medium based on this criterion because of periodic long periods of little or no extraction due to seasonal demands for reclaimed water. Alternatives 4, 5, and 6 are all ranked High based on this criterion because they extract and treat the most relatively contaminated water for treatment and in the largest volumes compared to the other alternatives.

Alternative 1 is not ranked.

### 4.3.5 Short-Term Effectiveness

Alternative 1 does not include any construction or other response actions; therefore, there would be no short-term risks to the community nor any short-term impacts to human health or the environment as a result of the remedy.

Alternatives 2 through 6 would all require the construction of one treatment plant of similar size.

Alternative 2 would require the installation of extraction wells in one area (LE, near the leading edge of the plume) and construction of 22,400 feet of pipeline. Alternatives 3 through 6 would require the installation of extraction wells throughout the plume (represented by the three areas LE, CE, and NE), and construction of 41,700; 33,200; 40,700; and 41,900 feet of pipeline, respectively. The requirements for pipeline construction and well installation under Alternatives 3 through 6 are approximately double those for Alternative 2.

In addition, Alternative 4 would require the installation of two injection wells.

It is expected that all the remedies would be constructed within 1 year of approval of final designs for each of the Alternatives 2 through 6. All construction activities would take place

at developed areas with minimal expected impacts to the environment. Noise and dust abatement during the construction and management and offsite disposal of the contaminated drill cuttings and purge water would be required to protect the community during the remedy implementation. Standard OSHA requirements would be protective of workers during the construction.

Alternatives 2 to 6 rank High on short-term effectiveness. Alternative 1 is not ranked.

#### **4.3.6 Implementability**

The No Action Alternative is by definition implementable.

Alternatives 2 through 6 are based on proven technologies for both construction and operation. It is expected that all construction permits would be obtained. The effectiveness of the treatment would be monitored by direct effluent sampling and analysis. The effectiveness of the capture would be monitored indirectly using groundwater monitoring wells, groundwater flow modeling, or other methods. The remedies could be modified, if necessary, to accommodate higher flow rates, additional extraction wells, or a different method of treatment.

Alternatives 2 through 6 can meet federal, state, and local permitting requirements. Although permits would not be required for any portion of the RA conducted onsite, the substantive aspects of all potential ARARs must be complied with.

In addition, all of the remediation alternatives would require access to water rights. For Alternatives 2, 3, and 6, which involve consumptive or beneficial water use, water rights would have to be obtained by leasing or buying them, or acquiring the use of water rights from a water rights holder by agreement.

Alternatives 4 and 5, which do not involve consumptive water use, would require temporary water rights be obtained from a water rights owner with an NWU Permit, which would require periodic permit renewal.

In addition, all the remedial alternatives produce unusable waste brine from the treatment process that is discharged to the sewer. This water would qualify for an NWU Permit.

Treatment of groundwater from an impaired source for potable use under Alternatives 2 and 6 would require the preparation of a CDPH 97-005 permit application and implementation of its requirements, including extensive monitoring and testing provisions.

The demand for reclaimed water generated under Alternative 3 is currently much lower than the existing available supply. In addition, reclaimed water demand has high seasonal fluctuations that would impair plume capture efficiency. Existing agreements between LACSD and CBMWD would have to be modified to allow CBMWD to preferentially accept OU2 reclaimed water over LACSD municipal reclaimed water when there is a demand for reclaimed water.

The reinjection of treated water under Alternative 4 would require extensive testing and a complicated regulatory review and permitting process. However, by directly recharging the drinking water aquifer, this alternative would benefit regional water reuse efforts.

The discharge to spreading basins under Alternative 5 would also require a complex regulatory review process and extensive testing. However, the OU2 treated water is not

viewed as a municipal source and would be considered “dilution water.” Consequently, its discharge would allow LACSD to send more reclamation water to the spreading basins, which would benefit regional water reuse efforts.

Alternatives 2 through 6 would generate waste brine as a byproduct of the TDS reduction. Although, by policy, LACSD does not want to accept groundwater into its POTW system, it is very likely that the agency would accept this wastewater because it is wastewater generated as part of a water reuse effort.

Water rights issues would have to be resolved through negotiations with the parties to the Central Basin judgment for Alternative 3 that withdraws water from the basin for consumptive reclaimed water use. Water rights would not be an impediment for the other alternatives because the treated water would be used for basin replenishment (Alternatives 4 and 5) or offset by commensurate reductions in pumping rates at existing production wells (Alternatives 2 and 6). The operator of the remedy would be required to acquire temporary water rights from a water rights holder; the temporary water rights would not count against the holder’s water allocation. If no water extraction offsets are provided for Alternatives 2 and 6, then basin replenishment fees would likely be assessed by the WRD.

The waste brine discharge under each alternative would be subject to an NWU Permit.

The regulatory and permitting requirements are the main distinguishing factors for the implementability of Alternatives 2 through 6. Based on these factors, Alternatives 2, 4, 5, and 6 rank Medium for this criterion. For Alternative 3, however, the lack of a consistent and large enough demand for reclaimed water is problematic resulting in a Low ranking. Alternative 1 is not ranked.

### 4.3.7 Cost

No cost is associated with Alternative 1.

The capital and annual O&M costs and total NPV for Alternatives 2 through 6 are presented in Table 4-2. Rounded to millions, Alternative 2 has the lowest NPV of \$54 million, followed by Alternative 6 at \$69 million, Alternative 4 at \$73 million, Alternative 5 at \$83 million, and Alternative 3 at \$87 million. The capital costs are the lowest for Alternative 2 at \$29 million, followed by \$38 million for Alternative 6, Alternative 3 at \$40 million, Alternative 4 at \$41 million, and Alternative 5 at \$42 million. Cost estimate details are provided in Appendix B for each alternative.

### 4.3.8 Green Cleanup Assessment

The sustainability assessment of the action alternatives is presented in Appendix C and summarized as follows. The evaluation focused on relative differences between the alternatives rather than absolute total environmental impact.

Alternative 1 had no assessment done because there is no remedial activity under the No Action Alternative.

Alternative 2 has the smallest environmental footprint followed by Alternative 4, and Alternatives 3, 5, and 6, with total scores of 1.8, 1.4, 1.3, 1.3, and 1.3, respectively. Accordingly, Alternative 2 is ranked Medium and Alternatives 3, through 6 are ranked Low.

This analysis did not account for the additional reclaimed water discharges to the ocean to offset the treated water under Alternative 3 (because of limited demand for reclaimed water). When this water offset is counted, the overall score for this alternative is the lowest at 1.1.

Alternative 2 scored the highest on total energy use and renewable energy and land management and ecosystems, while the remaining alternatives had similar scores. Alternatives 2, 4, and 6 scored the highest on air pollution and GHG emissions and materials management and waste reduction, while Alternatives 3 and 5 scored the lowest. Alternatives 3 and 5 scored the highest on water use and water resources, while Alternatives 2, 3, and 6 scored the lowest.

TABLE 4-1  
Criteria for Alternative Analysis  
*Feasibility Study, Omega Chemical Superfund Site OU2*

Category	Criteria	Analysis Factors	Considerations
Threshold Criteria	Overall Protection of Human Health and the Environment	Human Health Protection	Likelihood that the alternative reduces risk to human health from potential exposure to contaminants in groundwater.
		Environmental Protection	Level of protection provided to downgradient aquifers through hydraulic containment of future releases from the source areas.
	Compliance with ARARs	Chemical-specific applicable or relevant and appropriate requirements (ARARs)	Likelihood that the alternative will achieve compliance with chemical-specific ARARs within a reasonable period of time. If it appears that compliance with chemical-specific ARARs will not be achieved, evaluation of whether a waiver is appropriate.
		Location-specific ARARs	Likelihood that the alternative will achieve compliance with the location-specific ARARs (if any apply).  Evaluation of whether a waiver is appropriate if location-specific ARARs cannot be met.
Primary Balancing Criteria	Long-term Effectiveness and Permanence	Action-specific ARARs	Likelihood that the alternative will achieve compliance with action-specific ARARs. Evaluation of whether a waiver is appropriate if action-specific ARARs cannot be met.
		Magnitude of residual risks	Identity of remaining risks (risks from treatment residuals) and risks from untreated residual
	Reduction of Toxicity, Mobility, or Volume through Treatment	Adequacy and reliability of controls	Magnitude of the remaining risks. Likelihood that the technologies will meet required process efficiencies or performance specifications. Type and degree of long-term management required. Long-term monitoring requirements. Operation and maintenance functions that must be performed. Difficulties and uncertainties associated with long-term operation and main-tenance functions.
		Treatment process and remedy	Potential need for technical components replacement. Magnitude of threats or risks should the RA need replacement. Degree of confidence that controls can adequately handle potential problems. Uncertainties associated with land disposal of residuals and untreated wastes.
		Amount of hazardous material destroyed or treated	Likelihood that the treatment process addresses the principal threat. Special requirements for the treatment process.
		Reduction in toxicity, mobility, or volume	Portion (mass) of contaminant that is destroyed. Portion (mass) of contaminant that is treated.
		Irreversibility of treatment	Extent that the mass of contaminants is reduced. Extent that the mobility of contaminants is reduced. Extent that the volume of contaminants is reduced.
		Type and quantity of treatment residual	Extent that the effects of the treatment are irreversible. Residuals that will remain. Quantities and characteristics of the residuals. Risk posed by the treatment residuals.
	Short-term Effectiveness	Statutory preference for treatment as a principal element	Extent to which the scope of the action covers the principal threats. Extent to which the scope of the action reduces the inherent hazards posed by the principal threats at the Site.
		Protection of the community during the RA	Risks to the community that must be addressed. How the risks will be addressed and mitigated.
		Protection of workers during remedial actions (RAs)	Remaining risks that cannot be readily controlled. Risks to the workers that must be addressed. How the risks will be addressed and mitigated.
		Environmental impacts	Remaining risks that cannot be readily controlled. Environmental impacts that are expected with the construction and implementation of the alternative.
	Implementability	Time until RA objectives are achieved	Mitigation measures that are available and their reliability to minimize potential impacts. Impacts that cannot be avoided, should the alternative be implemented. Time to achieve protection against the threats being addressed. Time until any remaining threats are addressed. Time until RAOs are achieved.
		Technical Feasibility	
		Ability to construct and operate the technology	Difficulties associated with the construction. Uncertainties associated with the construction.
		Reliability of the technology	Likelihood that technical problems will lead to schedule delays.
		Ease of undertaking additional RA	Likely future RAs that may be anticipated. Difficulty implementing additional RAs.
		Monitoring considerations	Migration or exposure pathways that cannot be monitored adequately. Risk of exposure should the monitoring be insufficient to detect failure.
		Administrative Feasibility	
		Coordination with other agencies	Steps required to coordinate with regulatory agencies. Steps required to establish long-term or future coordination among agencies. Ease of obtaining permits for offsite activities, if required.
	Cost	Availability of Services and Materials	
		Availability of treatment, storage capacity, and disposal services	Availability of adequate treatment, storage capacity, and disposal services. Additional capacity that is necessary. Whether lack of capacity prevents implementation. Additional provisions required to ensure that additional capacity is available.
		Availability of necessary equipment and specialists	Availability of adequate equipment and specialists. Additional equipment or specialists that are required. Whether there is a lack of equipment or specialists. Additional provisions required to ensure that equipment and specialists are available.
		Availability of prospective technologies	Whether technologies under consideration are generally available and sufficiently demonstrated.  Further field applications needed to demonstrate that the technologies could be used full-scale to treat the waste at the Site. When technology should be available for full-scale use. Whether more than one vendor will be available to provide a competitive bid.
		Net present value (NPV) for capital and operations and maintenance costs for the lifetime of the remedy	Short-term and long-term costs for implementing each remedy.



TABLE 4-2

## Summary of Cost Analysis

*Omega Chemical Superfund Site OU2*

Alternative	Capital Cost	O&M Cost	NPV for O&M Cost	Total NPV
1	\$0	\$0	\$0	\$0
2	\$29,200,000	\$2,000,000	\$24,400,000	\$53,600,000
3	\$40,100,000	\$3,700,000	\$46,400,000	\$86,600,000
4	\$41,400,000	\$2,600,000	\$31,800,000	\$73,200,000
5	\$41,600,000	\$3,300,000	\$41,300,000	\$82,900,000
6	\$38,400,000	\$2,500,000	\$30,800,000	\$69,200,000

## Explanation

Total NPV is the sum of capital cost and NPV for O&M.

NPV is calculated using a 30-year remedy lifetime and 7% discount rate.

All costs are rounded to \$100,000.

NPV = net present value

O&M = operations and maintenance



TABLE 4-3  
Comparative Analysis of Remedial Alternatives  
Omega Chemical Superfund Site, OU2

Alternative	Description	Protection of Human Health and Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) Through Treatment	Short-term Effectiveness	Implementability	Cost (millions)		Green Assessment
1	No Action Alternative	<b>NO</b> – Provides no long-term protection of human health or the environment.	<b>NO</b>	<b>LOW</b> – Would allow uninhibited migration of the contaminants in groundwater.	<b>NA</b>	<b>NA</b>	<b>NA</b>		\$0	<b>NA</b>
2	Leading Edge Extraction with Drinking Water End Use	<b>NO</b> – Would not achieve complete capture of the plume by extraction at the leading edge. The capture in the vertical direction and lateral capture during changing hydrogeologic conditions would be uncertain.	<b>YES</b> – Meets all chemical-specific, location-specific, and action-specific applicable or relevant and appropriate requirements (ARARs).	<b>MEDIUM</b> – Would achieve capture but the vertical capture will likely be incomplete. Would allow contamination from high concentration zones to migrate into less contaminated zones within the plume. The overall plume size would initially increase, then decrease.	<b>MEDIUM</b> – The treatment would reduce the toxicity and mobility of contaminants removed from the extracted groundwater, but not to the extent provided by plumewide extraction in Alternatives 3 through 6. Alternative 2 only extracts at the leading edge (at a lower total flow rate than Alternatives 3 through 6), where contaminant of concern (COC) concentrations are much lower than within the more contaminated areas of Operable Unit (OU) 2 that would be pumped by Alternatives 3 through 6.	<b>HIGH</b> – The remedy can be constructed within 1 year of completion of design with minimal expected impacts to the environment.	<b>MEDIUM</b> – This alternative is based on proven technologies for both construction and operation and can be modified in the future, if necessary. Water rights would not be an impediment assuming that the purveyor(s) receiving OU2 treated water reduce their production well extraction rates commensurately, but coordination with purveyors would be necessary. Constructability is similar to the other alternatives. Complicated regulatory review and permitting process is expected as Policy Memo 97-005 requirements and permits would apply.	Capital Annual Operations and Maintenance (O&M) Net Present Value (NPV) of O&M Total NPV	\$29.2 \$2.0 \$24.4 \$53.6	<b>MEDIUM</b> – High score (low footprint) on categories of air pollution and greenhouse gas (GHG) emissions, materials management and waste reduction, and land management and ecosystems. Lower score on water resources because about 25 percent of the extracted water ends up in the waste brine that has no beneficial use.



TABLE 4-3  
Comparative Analysis of Remedial Alternatives  
Omega Chemical Superfund Site, OU2

Alternative	Description	Protection of Human Health and Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) Through Treatment	Short-term Effectiveness	Implementability	Cost (millions)		Green Assessment
3	Plumewide Extraction with Reclaimed Water End Use	<b>YES*</b> – Would achieve capture through extraction along the longitudinal axis of the plume if there is sufficient year round demand for reclaimed water; otherwise, overall plume capture efficiency would be impaired because of prolonged periods of little or no reclaimed water demand during which groundwater extraction rates would be significantly curtailed. It would permanently remove contamination from the extracted groundwater.	<b>YES</b> – Meets all chemical-specific, location-specific, and action-specific ARARs.	<b>HIGH</b> – Would achieve complete capture of the plume when operating. Would impede the spread of contamination from highly contaminated zones. The downgradient portion of the plume size would initially increase, then decrease. The low seasonal reclaimed water demand would necessitate lower extraction rates, which would negatively affect the plume capture; as a result, the capture would likely be incomplete.	<b>MEDIUM</b> – The treatment would reduce the toxicity and mobility of contaminants removed from the extracted groundwater; however, due to prolonged periods of reduced extraction due to low seasonal demand for reclaimed water, less contaminant mass would be removed compared to the other alternatives.	<b>HIGH</b> – The remedy can be constructed within 1 year of completion of design with minimal expected impacts to the environment.	<b>LOW</b> – This alternative is based on proven technologies for both construction and operation and can be modified in the future, if necessary. Water rights may be an issue and basin replenishment assessment fees may be incurred. Coordination with Water Replenishment District (WRD), Sanitation Districts of Los Angeles County (LACSD); main supplier of regional reclaimed water), and with purveyors would be necessary. Constructability is similar to other alternatives. All permits are expected to be acquired. This alternative has the lowest overall implementability as a stand-alone alternative. The possibility of combining this alternative with another end use alternative also has low implementability because regional reclaimed water supply far exceeds its demands and there would be no incentive to provide additional reclaimed water to this region.	Capital	\$40.1	<b>LOW</b> – Low score (high footprint) on the categories of air pollution and GHG emissions, materials management and waste reduction, and land management and ecosystems. Higher score on water resources because only about 12 percent of the extracted water ends up in the waste brine that has no beneficial use. However, the beneficial use of the treated water would be completely offset by discharges to the ocean of reclaimed water from other treatment facilities in the basin due to the limited demand for reclaimed water.
								Annual O&M	\$3.7	
								NPV of O&M	\$46.4	
								Total NPV	\$86.6	



TABLE 4-3  
Comparative Analysis of Remedial Alternatives  
Omega Chemical Superfund Site, OU2

Alternative	Description	Protection of Human Health and Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) Through Treatment	Short-term Effectiveness	Implementability	Cost (millions)		Green Assessment
4	Plumewide Extraction with Reinjection	<b>YES</b> – Would achieve capture through extraction along the longitudinal axis of the plume. It would permanently remove contamination from the extracted groundwater.	<b>YES</b> – Meets all chemical-specific, location-specific, and action-specific ARARs.	<b>HIGH</b> – Would achieve complete capture of the plume. The plumewide extraction can better maintain capture during changing hydrogeological conditions than the leading edge only extraction under Alternative 2. Would impede the spread of contamination from highly contaminated zones. The downgradient portion of the plume would initially increase in size, then decrease.	<b>HIGH</b> – The treatment provided would reduce the toxicity and mobility of contaminants removed from the extracted groundwater.	<b>HIGH</b> – The remedy can be constructed within 1 year of completion of design with minimal expected impacts to the environment.	<b>MEDIUM</b> – This alternative is based on proven technologies for both construction and operation and can be modified in the future, if necessary. Water rights would not be an impediment, but coordination with purveyors would be necessary. Constructability is similar to the other alternatives. Regulatory agencies may require more stringent treatment than assumed in the Feasibility Study (FS). Purveyors may oppose deep aquifer injection because of hypothetical, yet to be identified contaminants.	Capital	\$41.4	<b>LOW</b> – High score (low footprint) on categories of air pollution and GHG emissions, materials management and waste reduction, and land management and ecosystems. Lower score on water resources because about 25 percent of the extracted water ends up in the waste brine that has no beneficial use.
								Annual O&M	\$2.6	
								NPV of O&M	\$31.8	
								Total NPV	\$73.2	
5	Plumewide Extraction with Discharge to Spreading Basins	<b>YES</b> – Would achieve capture through extraction along the longitudinal axis of the plume. It would permanently remove contamination from the extracted groundwater.	<b>YES</b> – Meets all chemical-specific, location-specific, and action-specific ARARs.	<b>HIGH</b> – Would achieve complete capture of the plume. The plumewide extraction can better maintain capture during changing hydrogeological conditions than the leading edge only extraction under Alternative 2. Would impede the spread of contamination from highly contaminated zones. The downgradient portion of the plume would initially increase in size, then decrease.	<b>HIGH</b> – The treatment provided would reduce the toxicity and mobility of contaminants removed from the extracted groundwater.	<b>HIGH</b> – The remedy can be constructed within 1 year of completion of design with minimal expected impacts to the environment.	<b>MEDIUM</b> – This alternative is based on proven technologies for both construction and operation and can be modified in the future, if necessary. Water rights would not be an impediment, but coordination with purveyors would be necessary. Constructability is similar to the other alternatives. Complicated regulatory review and permitting process is expected.	Capital	\$41.6	<b>LOW</b> – Low score (high footprint) in the categories of air pollution and GHG emissions, materials management and waste reduction, and land management and ecosystems. Higher score on water resources because only about 12 percent of the extracted water ends up in the waste brine that has no beneficial use.
								Annual O&M	\$3.3	
								NPV of O&M	\$41.3	
								Total NPV	\$82.9	



TABLE 4-3  
Comparative Analysis of Remedial Alternatives  
Omega Chemical Superfund Site, OU2

Alternative	Description	Protection of Human Health and Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) Through Treatment	Short-term Effectiveness	Implementability	Cost (millions)		Green Assessment
6	Plumewide Extraction with Drinking Water End Use	<b>YES</b> – Would achieve capture through extraction along the longitudinal axis of the plume. It would permanently remove contamination from the extracted groundwater.	<b>YES</b> – Meets all chemical-specific, location-specific, and action-specific ARARs.	<b>HIGH</b> – Would achieve complete capture of the plume. The plumewide extraction can better maintain capture during changing hydrogeological conditions than the leading edge only extraction under Alternative 2. Would impede the spread of contamination from highly contaminated zones. The downgradient portion of the plume would initially increase in size, then decrease.	<b>HIGH</b> – The treatment provided would reduce the toxicity and mobility of contaminants removed from the extracted groundwater.	<b>HIGH</b> – The remedy can be constructed within 1 year of completion of design with minimal expected impacts to the environment.	<b>MEDIUM</b> – This alternative is based on proven technologies for both construction and operation and can be modified in the future, if necessary. Water rights would not be an impediment assuming that the purveyor(s) receiving OU2 treated water reduce their production well extraction rates commensurately, but coordination with purveyors would be necessary. Constructability is similar to the other alternatives. Complicated regulatory review and permitting process is expected as Policy Memo 97-005 requirements and permits would apply.	Capital	\$38.4	<b>LOW</b> – High score (low footprint) on categories of air pollution and GHG emissions, materials management and waste reduction, and land management and ecosystems. Lower score on water resources because about 25 percent of the extracted water ends up in the waste brine that has no beneficial use.
								Annual O&M	\$2.5	
								NPV of O&M	\$30.8	
								Total NPV	\$69.2	

Note:  
NPV is based on 30-year operation at a 7% discount rate.



## 5. References

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ARCADIS. 2007. Final Project Completion Report – Well Installation and Groundwater Monitoring, Omega Chemical Operable Unit 2, Whittier, California. Prepared for the Omega Small Volume Group (OSVOG). March 2.

California Department of Water Resources (CDWR). 1961. “Bulletin 104. Planned Utilization of the Ground Water Basins of the Coastal Plain of Los Angeles County.” *Appendix A, Groundwater Geology*.

California Regional Water Quality Control Board (RWQCB). 1994. Water Quality Control Plan, Los Angeles Region. June 13.

Camp, Dresser & McKee (CDM). 2001. *Data Summary Report for On-Site Soils. Omega Chemical Superfund Site, Whittier, California*. Prepared for Omega Chemical Site PRP Organized Group. December 4.

Camp Dresser & McKee (CDM). 2003. *On-Site Soils Remedial Investigation/Feasibility Study Work Plan*. Prepared for the Omega Chemical Site PRP Organized Group. September 29.

CH2M HILL. 2010. *Final Remedial Investigation Report Omega Chemical Corporation Superfund Site Operable Unit 2, Los Angeles County, California*. Prepared by CH2M HILL.

Moore, Toby. 2009. Email Communication. Production well data for the three wells owned by the Golden State Water Company. June 9, 2009.

Reichard, E.G., M. Land, S.M. Crawford, T. Johnson, R.R. Everett, T.V. Kulshan, D.J. Ponti, K.J. Halford, T.A. Johnson, K.S. Paybins, and T. Nishikawa. 2003. “Geohydrology, Geochemistry, and Ground-Water Simulation – Optimization of the Central and West Coast Basins, Los Angeles County, California.” *Water Resources Investigations Report 03-4065*. U.S. Geological Survey.

Science Applications International Corporation (SAIC). 2006. *12504 Whittier Boulevard, Whittier, CA & 12512 Whittier Boulevard, Whittier, CA – Facility History*. Prepared for Linda Ketellapper (U.S. EPA, Region 9). July 10.

Saucedo, G.J., Greene, H.G., Kennedy, M.P., and Bezore, S.P. 2003. “Geologic Map of the Long Beach 30' x 60' quadrangle, Version 1.0, California.” *California Geological Survey, Preliminary Geologic Maps* (scale 1:100,000).

U.S. Environmental Protection Agency (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. U.S. EPA Office of Emergency and Remedial Response, Washington D.C. EPA/540/G-89/004. October.

U.S. Environmental Protection Agency (EPA). 1990. *National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule, Federal Register*. March 8, 1990: 8670-8852.

U.S. Environmental Protection Agency (EPA). 1993. *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*. August.

U.S. Environmental Protection Agency (EPA). 2004a. *Unilateral Administrative Order for Response Actions, Docket Number 9-2004-004*. Issued to Omega Chemical Corporation and Respondents. January 4.

U.S. Environmental Protection Agency (EPA). 2004b. *First Amended Unilateral Administrative Order for Response Actions, Docket Number 9-2004-004*. Issued to Omega Chemical Corporation and Respondents. June 29.

U.S. Environmental Protection Agency (EPA). 2006. *Request for a Removal Action at the Omega Chemical Site, Whittier, California*. Action Memorandum for Vapor Intrusion prepared for the Site Cleanup Branch. April 6.

U.S. Environmental Protection Agency (EPA). 2009. *Draft Framework for Green Cleanup Standards at Contaminated Sites*. April 1.

Water Replenishment District of Southern California (WRD). 2008. *Regional Groundwater Monitoring Report Water Year 2006-2007, Central and West Coast Basins Los Angeles County, California*. March.

Weston Solutions, Inc. (Weston). 2002. *Omega Chemical Superfund Site, Whittier, California. Phase 1 Groundwater Characterization Study*. Prepared for U.S. Environmental Protection Agency, Region IX. February.

Weston Solutions, Inc. (Weston). 2003. *Omega Chemical Superfund Site, Whittier, California. Phase 2 Groundwater Characterization Study*. Prepared for U.S. Environmental Protection Agency, Region IX. June.

Weston, Roy F., Inc. 2001. *Sampling and Analysis Plan, Omega Chemical, Whittier, California*. July 26.

## Appendix A

### Groundwater Modeling

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# A.1 Introduction

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This appendix describes the groundwater modeling conducted in support of the Feasibility Study (FS) for the Omega Chemical Corporation Superfund Site, Operable Unit 2 (OU2). The numerical groundwater flow model for OU2 developed during the Remedial Investigation (RI) has been updated and refined to develop the numerical tools for the evaluation of the FS remedial scenarios (CH2M HILL, 2009).

The RI model for OU2 was based on a numerical model previously developed by the United States Geological Survey (USGS) for the Central and the West Coast basins in Los Angeles, California (USGS, 2003). The RI model was implemented using Finite Element subsurface FLOW system (FEFLOW) (Diersch, 2005). The model domain covers the eastern portion of the Central Basin (Figure A-1). Model boundaries include no-flow boundary along the Puente Hills; specified head boundary representing the groundwater inflow from the San Gabriel Basin through the Whittier Narrows; specified head boundaries for the southeast and the northwest boundaries, representing the groundwater exchange between the modeled areas and adjacent areas; and specified flux boundary representing the minor outflow across the Newport-Inglewood Uplift (NIU). Other major inflow and outflow components represented in the model included recharge from precipitation, mountain front recharge, recharge from return flow, recharge from spreading basins and unlined section of river channels, and groundwater extraction and injection (Figure A-2). The RI model has 13 model layers representing the stratigraphic units identified in the Omega OU2 area including the Lower and Upper San Pedro formations, the Pleistocene, and the Holocene units. The RI model simulates groundwater flow in the Omega OU2 area for a period of about 36 years, between October 1970 and July 2006 (CH2M HILL, 2009).

The conceptual hydrostratigraphic model for OU2 remains unchanged from that described in the RI report (CH2M HILL, 2009). The numerical model for OU2 also remains largely unchanged; that is, model domain, layering, boundary conditions and inflow and outflow components incorporated in the FS models are the same as those in the RI model.

The most important update made to the RI model is the development of a steady-state flow model suitable for auto-calibration using PEST (Doherty, 2008), which serves as the base flow model for the FS simulations. The transient flow model was also updated by extending the simulation period through 2008 to include recently acquired aquifer data. Solute transport models were also developed based on the calibrated steady-state flow model.

The FS flow models were used to assist in the screening processes of the containment scenarios, to estimate the extraction rates, and to select well locations needed to achieve the remedial action objectives. Solute transport modeling was performed to further evaluate the different remedial scenarios.



## A.2 Flow Modeling

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The RI model for the Omega OU2 area was calibrated against historical water level measurements between October 1970 and July 2006 in a traditional zonal approach using both manual calibration and PEST. An emerging calibration technique, namely the regularization pilot point approach utilized in PEST, is more objective in that it does not require the specification of parameter zones, and thus, offers the promise of reducing parameter uncertainties. PEST was developed by Dr. John Doherty of the Watermark Numerical Computing of Australia (Doherty, 2008).

For a complex regional groundwater flow model such as the OU2 model, the flow model is called and executed many times (in thousands) during calibration by the pilot point method. A steady-state model with fast execution time makes it more practical to use this approach. As such, a steady-state flow model for the OU2 area was developed, and calibration of the model was accomplished with PEST. In addition, distributions of hydraulic conductivities resulting from the steady-state model calibration were incorporated into the updated transient model, used to simulate the groundwater flow for the OU2 area for the period between October 1970 and September 2008; the fit of the transient model simulated heads to observed heads was used as a check for the estimated hydraulic conductivity distribution.

### A.2.1 Steady-State Flow Model

The relatively constant groundwater flow regime (defined by the observed groundwater flow direction and gradient) in the OU2 area indicates that a steady-state model can adequately simulate groundwater flow within this aquifer. As such, a steady-state flow model was developed for OU2.

#### A.2.1.1 Development of A Steady-State Flow Model

The steady-state flow model was developed to simulate the average groundwater flow regime for OU2 area by revising the RI transient model (that is, replacing the time variant inflow and outflow components with constant values).

- The northeastern no-flow boundary along the Puente Hills and the constant flux boundary along the NIU remain unchanged. The NIU is a known groundwater flow barrier and water exchange across NIU is limited.
- The specified heads along the southeast and the northwest boundaries were based on RI transient model simulated water levels for July 2006. The specified head boundaries were intentionally placed perpendicular to the groundwater contour lines simulated by the USGS model to minimize groundwater flow across the head boundaries (they are effectively no-flow boundaries along most of their length).
- The specified head boundary representing groundwater inflow from the San Gabriel Basin through the Whittier Narrows was based on the water levels observed in July 2007 at the two monitoring wells located along the boundary, 2S/11W-5L1 and 2S/11W-6G2 (Figure A-2).

- For the other major inflow and outflow components, including areal recharge, mountain front recharge, recharge from spreading basins and unlined section of river channels, and groundwater extraction and injection, simple arithmetic mean values for these various inflow and outflow components were calculated for the period between October 1970 and September 2008 and assigned to the steady-state flow model.

### A.2.1.2 Calibration of the Steady-state Model

The steady-state flow model for Omega OU2 area was calibrated against the groundwater flow conditions observed in the third quarter of 2007, a time period with the most water level measurements within the model domain. (The wells in the downgradient portion of OU2 were installed in 2007 during the RI.)

#### Approach

Model calibration was achieved with the pilot point approach using PEST. Similar to the RI model calibration, hydraulic parameters allowed to vary during calibration include horizontal hydraulic conductivity for the top nine model layers representing the Holocene and the Pleistocene units; model parameters for the other deeper model layers representing the Lower and the Upper San Pedro formations were kept constant. The adjustment of model parameters was laterally limited to the area of interest to the Omega study (that is, the area to the east of the San Gabriel River and north of the Norwalk Fault, shown in Figure A-3); parameters outside the area of interest were kept constant during calibration. This area of adjustment includes OU2 and encompasses the known volatile organic compounds (VOC) contaminant plumes and potential contaminant source areas. In addition, the horizontal to vertical anisotropy ratio (defined as the ratio between the horizontal and vertical hydraulic conductivity) was also adjusted through model calibration. The adjustment was also laterally limited to the area of interest. Calibration of the steady-state model was achieved by constraining the model calibration with the hydraulic conductivity values derived from the pumping tests conducted on the Omega wells as summarized in Table A-1. Figure A-3 shows the locations of these Omega wells.

#### PEST Setup

PEST 11.0 was used to estimate the distributions of horizontal hydraulic conductivities in the different model layers. The pilot point approach was employed for the estimation of the horizontal hydraulic conductivity distributions for the model layers representing the water-bearing units (model layers 1, 2, 3, 4, 5, 6, and 8, with 6 and 8 assuming the same parameter distribution as layer 5). The same set of pilot points was used for all model layers (Figure A-3). For the model layers representing the confining unit (layers 7 and 9), fewer pilot points were used, and most of the pilot points were tied to each other during calibration to reduce computer time. A single parameter representing the anisotropy ratio for all nine top model layers was estimated by PEST.

#### Calibration Wells

Third quarter 2007 water level measurements from the monitoring wells located in the vicinity of the Omega OU1 and OU2 areas were used to calibrate the steady-state model. These include Omega OU1 monitoring wells OW1 through OW8 and OU2 monitoring wells MW1 through MW30. Some of these monitoring wells are co-located and screened at different depth intervals; these are referred to as well clusters. Well clusters for the OU1

area include OW1A/1B, OW3A/3B, OW4A/4B, and OW8A/8B. Well clusters for the OU2 area include MW1A/1B, MW4A/4B/4C, MW8A/8B/8C/8D, MW9A/9B, MW13A/13B, MW16A/16B/16C, MW17A/17B/17C, MW18A/18B/18C, MW20A/20B/20C, MW23A/23B/23C/23D, MW24A/24B/24C/24D, MW25A/25B/25C/25D, MW26A/26B/26C/26D, and MW27A/27B/27C/27D.

Efforts were made to include other facility-specific monitoring wells and regional monitoring wells located within OU2. The monitoring wells were limited to the ones with available construction data and water level measurements. These include two Oil Field Reclamation Project (OFRP) facility wells, 27 Ashland Chemical (Ashland) wells, and one regional monitoring well (with state identification number 3S/12W-01A6). In addition, the water table contours for the OU2 aquifer for the third quarter of 2007 were digitized and included in model calibration as an additional constraint. Figure A-4 shows the locations of the monitoring wells included in the model calibration.

### Calibration Evaluation Criteria

Calibration of the steady-state model was evaluated by the scatter plot of the measured versus modeled hydraulic heads for all the calibration wells, and by the selected statistic measures for the goodness-of-fit, including the mean error (ME), the root mean squared (RMS) error, and the RMS normalized to the spread of the observed water levels in the OU2 area (%RMS). The calibration goal is to minimize RMS and ME.

Water table contours reveal the general groundwater flow pattern for the unconfined aquifer. The simulated water table contours were compared with the observed water table contours to qualitatively assess the ability of the model to reproduce the observed groundwater flow pattern.

In addition, particle tracking was used to confirm the appropriateness of the flow fields simulated by the calibrated model. Particles were released from identified major contaminant source areas, namely the Omega, Angeles, and McKesson facilities, and the resulting flow paths were compared with the known VOC plumes. The appropriateness of the simulated flow fields can be qualitatively assessed by the agreement between the model-predicted particle flow lines and the observed VOC plume extent. Tetrachloroethene (PCE), the most widely distributed VOC in the study area, was chosen as the indicator contaminant, and the July 2007 PCE plume (Figure 5-11 of the RI report) was used in the particle-tracking evaluation.

### Calibration Results

Table A-2 compares the measured and the simulated water levels. It also includes the summary statistics for quantitative evaluation of the model calibration. The ME, RMS and %RMS for all the calibration wells are -0.32 feet, 3.48 feet, and 2.82 percent, respectively.

The observed water levels for all the calibration wells were plotted versus the simulated water levels (Figure A-5). The match between simulated and observed water levels is measured by the square of the Pearson product moment correlation coefficient ( $R^2$ ); the match was good with an  $R^2$  value of 0.97. Figure A-5 also shows that the residuals between the modeled and measured water levels were generally small and randomly distributed with no apparent systematic errors.

Figure A-6 compares the simulated and observed water table contours for the third quarter of 2007. The good match between the simulated and the observed water table contours indicates that the calibrated model was able to reproduce the observed groundwater flow regime in the aquifer in the study area.

Figure A-7 shows the model simulated particle pathlines in comparison with the observed PCE plume at OU2. The simulated particle pathlines are in good agreement with the axis of the PCE plume (the zone of the high PCE concentrations, which is interpreted as the main contaminant transport pathway), indicating that the numerical model is able to mimic the advective movement of contaminants in the aquifer at OU2.

### **Calibrated Hydraulic Conductivity Distributions**

Figure A-8 shows the distributions of horizontal hydraulic conductivity in the various model layers resulting from the steady-state flow model calibration. Minor adjustments have been made to the PEST-calibrated hydraulic conductivity distributions based on particle tracking results.

For the horizontal to vertical anisotropy ratio, the model calibrated value was 334.8. This ratio reflects the much higher hydraulic conductivity in the horizontal direction than in the vertical direction, largely caused by the presence of thin, fine-grained units of low permeability.

## **A.2.2 Updated Transient Flow Model**

### **A.2.2.1 Extended Simulation Period**

The simulation period of the RI model was extended from July 2006 to September 2008 to include the most recent aquifer data. Water levels and pumping rates for the extended time period were obtained from the Water Replenishment District of Southern California (WRD); precipitation and spreading basin data were obtained from the Los Angeles County Department of Public Works (LACDPW). The time variant functions defining the different recharge and discharge flow components in the model were updated to include the extended time period.

### **A.2.2.2 Incorporation of Steady-state Model Calibrated Hydraulic Parameters**

The transient model with extended simulation period was further updated by incorporating the hydraulic conductivity distributions from the steady-state flow model calibration. The updated transient model was used to simulate groundwater flow condition in the Omega OU2 area from October 1970 to September 2008.

The storage parameters, namely the specific yield (ranging from 0.05 to 0.3) for the unconfined aquifer and the specific storage ( $5.0 \times 10^{-6}$  per meter) for the confined aquifer were the same as those used in the RI transient model. Figure A-9 shows the distribution of the specific yield in the Omega Model.

### **A.2.2.3 Simulation Results of the Updated Transient Model**

The capability of the updated transient model in reproducing the groundwater flow condition was assessed by comparing the simulated and observed water levels at the various monitoring wells. Evaluation criteria include visual inspection of the scatter plot of

measured versus modeled hydraulic heads (Figure A-10), visual inspection of the simulated and observed hydrographs at individual monitoring wells (Figure A-11), statistical measures quantifying the goodness of model fit including the ME, the RMS and the %RMS (Table A-3), and comparison of simulated water table contours with the observed ones (Figure A-12).

The updated transient model was generally able to reproduce the observed spatial and temporal water level changes in the study area, as indicated by the generally good match between the observed and the simulated hydrographs (Figure A-10). The %RMS was 10 percent or less for all well categories (Table A-3). The simulated water table contours for July 2007 also closely match the observed ones (Figure A-12), indicating the model's capability to regenerate the observed flow regime for the selected time period.

It is noted that the transient model was not able closely mimic the observed vertical water level separations for some of the cluster wells located near the Omega facility (e.g., OW3A/3B, OW4A/4B, and OW8A/8B) (Figure A-11). This incapability of the model is, however, considered insignificant for the purpose this modeling exercise for the following reasons:

- The FS model is used to estimate extraction locations and rates to meet the containment objectives. The proposed extraction wells are placed at locations down-gradient of the Omega facility; and more importantly,
- The extraction system is designed to contain the entire depth of the contaminated aquifer (up to 200 feet bgs). In this sense, the contaminated aquifer is treated as one single unit for the purpose of containment.

In summary, the transient model is in general able to regenerate the observed flow regime in OU2 aquifer.



## A.3 Remedial Scenario Simulations

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The goal of this modeling effort is to assist in developing and evaluating the different FS remediation alternatives for the Omega OU2. With the exception of the no-action alternative, all the four active FS alternatives propose extraction of contaminated groundwater at different locations. These four active FS alternatives are differentiated based on the end use of the treated groundwater and on the distribution of pumping. The flow model is used to develop and evaluate the FS alternatives with active pumping/extraction by estimating the extraction locations and extraction rates required to meet the containment objectives.

### A.3.1 Approach

The calibrated steady-state flow model was used to simulate the groundwater flow conditions in the Omega OU2 area under different remedial pumping scenarios. Specifically, FS Alternative 1 is the no-action scenario, and therefore, modeling simulation was not performed. Alternative 2 involves extraction of groundwater at the Leading Edge Extraction (LE) of the current plume to contain contaminated groundwater. The other three alternatives propose plumewide extractions. That is, in addition to extracting groundwater at the leading edge, extraction of highly contaminated groundwater at two locations downgradient of the known contaminant source zones is proposed to more effectively contain or remove groundwater contamination. The two extraction locations are referred to as the Northern Extraction (NE) and Central Extraction (CE). Extraction is represented in the model by two wells at LE, one well at CE, and one well at NE; the actual remedy would include multiple extraction wells at each location, and the pumping could be distributed among the individual extraction wells at each location.

It is assumed that the extraction components of the remedial system for the three FS alternatives proposing plumewide extraction are the same. This assumption is deemed reasonable because model simulation indicates that neither reinjection of treated water into deep aquifer (layers 10 and below) nor discharge of treated water into the San Gabriel Spreading Basin will negatively impact the effectiveness of the extraction system. As such, simulations were conducted under two pumping scenarios:

- Leading extraction
- Plumewide extraction

A target capture zone was established based on the PCE contaminant distributions at OU2 (Figures A-13 and A-14). Forward particle tracking was employed to delineate well capture zones. Particles are released at different depths within the aquifer where PCE contamination was observed. The model simulated capture zones were compared with the target capture zone.

## A.3.2 Results of Pumping Scenario Simulations

### A.3.2.1 Scenario with Leading Edge Extraction

Figure A-13 shows the model-simulated well capture zones at three different depth intervals within the omega OU2 aquifer for the pumping scenario where extraction occurs only at the LE of the current PCE plume. The modeling indicates that a combined extraction rate of 1,150 gallons per minute (gpm) at the LE of the current PCE plume is required in order to prevent further downgradient migration of contaminated groundwater.

### A.3.2.2 Scenario with Plumewide Extraction

Figure A-14 shows the model-simulated well capture zones at three different depth intervals within the aquifer at OU2 for the pumping scenario assuming plumewide extraction. The modeling indicates that a combined extraction rate of 1,300 gpm is required to mitigate migration of contaminated groundwater, with CE and NE extraction at 350 gpm each and LE extraction at 600 gpm.

## A.4 Solute Transport Modeling

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Solute transport simulations were performed to complement capture zone analysis and further evaluate effectiveness of the FS alternatives. Specifically, the main objective of the solute transport modeling is to estimate future plume migration under certain assumptions for the different pumping scenarios.

### A.4.1 Solute Transport Model Development

The solute transport simulations were performed using FEFLOW with some modifications to the groundwater flow model. Model layering and flow parameters remain the same as those of the calibrated steady-state flow model. Model mesh was refined in the plume area to increase computational accuracy. No attempt was made to calibrate the transport model.

The transport modeling objective is to compare the effectiveness of the pumping scenarios used in the remedial alternatives relative to each other. Therefore, simplified assumptions can be made (such as source control, absence of reactions) to aid the modeling effort.

The transport processes incorporated in the transport models include advection and hydrodynamic dispersion. Sorption of contaminants onto sediment surfaces and degradation of contaminants were not simulated by the transport models for OU2. (It is noted that FEFLOW can simulate these processes.) The solute transport parameter values used in the transport models are the same as those used during the RI modeling and they represent typical values for a sandy aquifer. The effective porosity value assumed for the transport modeling is 0.3; the longitudinal and transverse dispersivity values used in the transport models were 100 meters and 0.5 meters, respectively.

The transport simulations were prepared for PCE because it is the most widespread contaminant at OU2, is present at the highest concentrations at OU2, and presents the highest potential risk to human receptors of all contaminants of concern in groundwater at OU2.

In all transport scenarios, an initial distribution of PCE in groundwater was assigned to the model layers corresponding to the depth interval where contamination was observed. The initial distribution was based on the interpreted extent of the PCE plume in July 2007. It is assumed that source control measures have been implemented at OU1 (where the interim groundwater system operation has started in July 2009) and at all other source areas at OU2, and that these measures are effective in preventing the flux of contaminants into the groundwater at OU2. As such, no source term was simulated by the transport models.

### A.4.2 Transport Simulation Results

Transport modeling was conducted to simulate future evolution of the current VOC contaminant plume in the Omega OU2 area under different pumping scenarios, as specified in the different FS remedial alternatives. Three pumping scenarios were simulated in the transport models:

- No-action
- Leading edge extraction
- Plume-wide extraction

For each pumping scenario, a transport model was used to generate contaminant plume after 5, 10, 20, and 30 years at three different depth intervals that correspond to the upper, middle, and lower portions of the contaminated aquifer at OU2. The effectiveness of each pumping scenario was assessed by these predicted plumes.

For the no-action scenario (Figures A-15-1 through A-15-3), the transport model predicts persistence of PCE contamination with greater than 100 micrograms per liter ( $\mu\text{g/L}$ ) concentrations in the aquifer for over 30 years. In addition, the current plume will continue to expand into the downgradient area; the downgradient migration was more pronounced in the deeper portion of the aquifer.

For the leading edge extraction scenario (Figures A-16-1 through A-16-3), the transport model indicates that the proposed extraction system was effective in preventing migration of contaminated groundwater beyond the extraction wells near the current leading edge of the PCE plume. However, the model also predicts persistence of PCE contamination with concentrations in the aquifer greater than 100  $\mu\text{g/L}$  for over 30 years.

For the plumewide extraction scenario (Figures A-17-1 through A-17-3), the transport model indicates that the proposed extraction system was effective in preventing migration of contaminated groundwater beyond the current leading edge of the PCE plume. In addition, compared with the leading edge extraction scenario, PCE concentrations in the aquifer decrease more rapidly over time, suggesting faster cleanup of the contaminated aquifer.

## A.5 Model Uncertainties

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The presented numerical groundwater flow and transport models are believed to be reasonable numerical representations of the aquifer system at OU2, and they are believed to be adequate numerical tools for evaluating the FS remedial alternatives. However, groundwater model predictions are subject to uncertainties and limitations typically associated with any groundwater modeling effort. The current modeling exercise is no exception.

The flow model is believed to be adequately calibrated and it simulates the observed groundwater flow regime in the Omega OU2 area well. The solute transport modeling was conducted under certain assumptions regarding the source term and initial contaminant distributions. The transport parameters assume values typical for a sandy aquifer because the main transport pathways at OU2 are via sandy units. The transport models were developed for the purpose of comparing the effectiveness of the different pumping scenarios. The transport models are not intended to serve as numerical tools to predict future contamination concentrations in groundwater at OU2.



## A.6 References

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CH2M HILL. 2009. *Draft Remedial Investigation Report Omega Chemical Corporation Superfund Site Operable Unit 2, Los Angeles County, California*. Prepared for U.S. Environmental Protection Agency. March.

Diersch, H.-J.G.. *FEFLOW, Finite Element Subsurface Flow & Transport Simulation System, Reference Manual*. 2005. Also available online at: <http://www.feflow.info/>.

Doherty, John. 2008. PEST - Model-Independent Parameter Estimation. Also available online at: <http://www.parameter-estimation.com/>.

United States Geological Survey (USGS). 2003. *Geohydrology, Geochemistry, and Ground-Water Simulation-Optimization of the Central and West Coast Basin, Los Angeles County, California*.



## Appendix A Tables

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**TABLE A-1**  
Summary of Horizontal Hydraulic Conductivity Used  
as Physical Constraints for PEST Calibration

<b>Well ID</b>	<b>Horizontal Conductivity (feet per day)</b>
OW1A	0.98
EW1	404
MW23A	95
MW24A	342
MW24C	255
MW26A	186
MW26B	316
MW27A	54
MW27B	45
MW30	289



Table A-2. Summary of Model Calibration Results

Well_ID	Measured (ft amsl)	Simulated (ft amsl)	Residual (ft)	Well_ID	Measured (ft amsl)	Simulated (ft amsl)	Residual (ft)
Omega OU1 wells				MW23D	116.0	113.7	2.2
OW1A	136.3	134.0	2.3	MW24A	125.4	120.8	4.6
OW1B	129.5	130.3	-0.8	MW24B	120.4	120.8	-0.4
OW2	133.7	130.7	3.0	MW24C	120.0	120.9	-0.8
OW3A	133.7	130.4	3.3	MW24D	119.8	117.0	2.8
OW3B	120.6	129.4	-8.8	MW25A	110.5	109.8	0.7
OW4A	126.8	123.4	3.4	MW25B	110.2	110.0	0.2
OW4B	120.1	122.8	-2.7	MW25C	106.4	105.3	1.1
OW5	123.5	120.3	3.2	MW25D	80.7	80.5	0.2
OW6	126.0	121.6	4.4	MW26A	88.9	91.4	-2.4
OW7	138.2	135.6	2.6	MW26B	88.9	90.5	-1.7
OW8A	133.9	130.4	3.5	MW26C	75.4	75.7	-0.3
OW8B	121.0	127.7	-6.7	MW26D	73.5	75.7	-2.2
Omega OU2 wells				MW27A	62.5	63.5	-1.0
MW1A	124.3	120.5	3.8	MW27B	62.6	62.0	0.6
MW1B	124.7	120.5	4.2	MW27C	47.4	49.1	-1.7
MW2	124.2	120.4	3.8	MW27D	47.6	49.1	-1.5
MW3	123.1	120.2	2.9	MW28	46.1	47.6	-1.5
MW4A	121.5	118.3	3.2	MW29	26.3	25.2	1.1
MW4B	121.5	118.1	3.4	MW30	14.8	22.8	-8.0
MW4C	120.1	118.1	2.0	Ashland wells			
MW5	123.3	119.1	4.2	ASH_EX-1	100.7	103.5	-2.8
MW6	122.9	118.5	4.4	ASH_EX-2	99.8	101.7	-1.9
MW7	120.7	119.5	1.2	ASH_EX-4	100.0	101.5	-1.5
MW8A	121.5	117.0	4.5	ASH_EX-5	101.1	104.4	-3.4
MW8B	121.6	117.0	4.6	ASH_MW-12R	101.1	104.2	-3.0
MW8C	120.7	116.9	3.8	ASH_MW-13R	101.3	104.4	-3.1
MW8D	115.5	117.3	-1.9	ASH_MW-14A	102.4	106.5	-4.2
MW9A	121.5	117.3	4.2	ASH_MW-14B	102.4	106.5	-4.1
MW9B	116.8	117.3	-0.5	ASH_MW-15A	98.0	95.0	3.0
MW10	113.4	109.5	4.0	ASH_MW-15B	92.4	95.0	-2.6
MW11	114.4	112.0	2.4	ASH_MW-16B	86.4	87.3	-1.0
MW12	137.7	132.7	5.0	ASH_MW-17A	97.9	97.8	0.1
MW13B	123.1	128.8	-5.7	ASH_MW-17B	97.8	97.8	0.0
MW14	126.2	121.4	4.8	ASH_MW-1R	101.6	105.0	-3.4
MW15	123.1	118.6	4.5	ASH_MW-21A	91.7	94.2	-2.6
MW16A	106.4	105.3	1.0	ASH_MW-21B	81.2	94.3	-13.1
MW16B	105.2	105.7	-0.5	ASH_MW-22	104.3	107.7	-3.4
MW16C	101.8	98.9	2.8	ASH_MW-23	102.5	106.1	-3.6
MW17A	95.3	95.3	0.0	ASH_MW-24	100.6	103.4	-2.8
MW17B	95.7	94.9	0.8	ASH_MW-25	101.4	104.6	-3.2
MW17C	78.2	80.9	-2.7	ASH_MW-26	100.5	103.0	-2.5
MW18A	116.8	117.9	-1.0	ASH_MW-27	100.1	102.4	-2.3
MW18B	116.9	117.0	-0.2	ASH_MW-2R	101.8	105.0	-3.2
MW18C	113.9	112.6	1.4	ASH_MW-4R	99.7	101.0	-1.4
MW19	90.7	90.7	0.0	ASH_MW-5	96.4	97.3	-0.9
MW20A	75.2	78.6	-3.4	ASH_MW-6R	97.7	99.4	-1.6
MW20B	74.7	75.5	-0.8	ASH_MW-7	102.5	106.3	-3.8
MW20C	56.1	58.0	-1.9	OFRP wells			
MW21	78.0	84.2	-6.3	OFRP_MW19	95.2	101.0	-5.9
MW22	88.1	94.4	-6.3	OFRP_MW21	98.6	97.3	1.3
MW23A	120.9	117.1	3.8	Regional Well			
MW23B	120.1	117.1	3.0	3S/12W-01A6	74.0	79.4	-5.4
MW23C	116.4	118.3	-1.9				
Summary Statistics:							
ME = -0.32 ft;		RMS = 3.48 ft;		%RMS = 2.82%			

Note:

- ME = Mean error in feet
- RMS = root mean squared error in feet
- %RMS = RMS normalized to the observed water level fluctuation in the Regional Water Table aquifer (123.39 feet);  
the water level fluctuation is calculated by the maximum and the minimum water levels observed in 3rd quarter 2007.



Table A-3. Summary Statistics of Transient Model Simulation

Well Category	Summary of Water Level Measurements				Summary of Calibration Results		
	# of Measurements	Max (ft amsl)	Min (ft amsl)	Range (ft)	ME (ft)	RMS (ft)	%RMS
Omega Wells	754	141	54	87	2.0	4.5	5%
Other Facility Wells	128	148	55	93	4.6	9.3	10%
Regional Wells	1651	164	-113	277	6.5	20.1	7%
All Wells	2533	164	-113	277	5.1	16.5	6%

Note:

ft amsl : ft above mean sea level

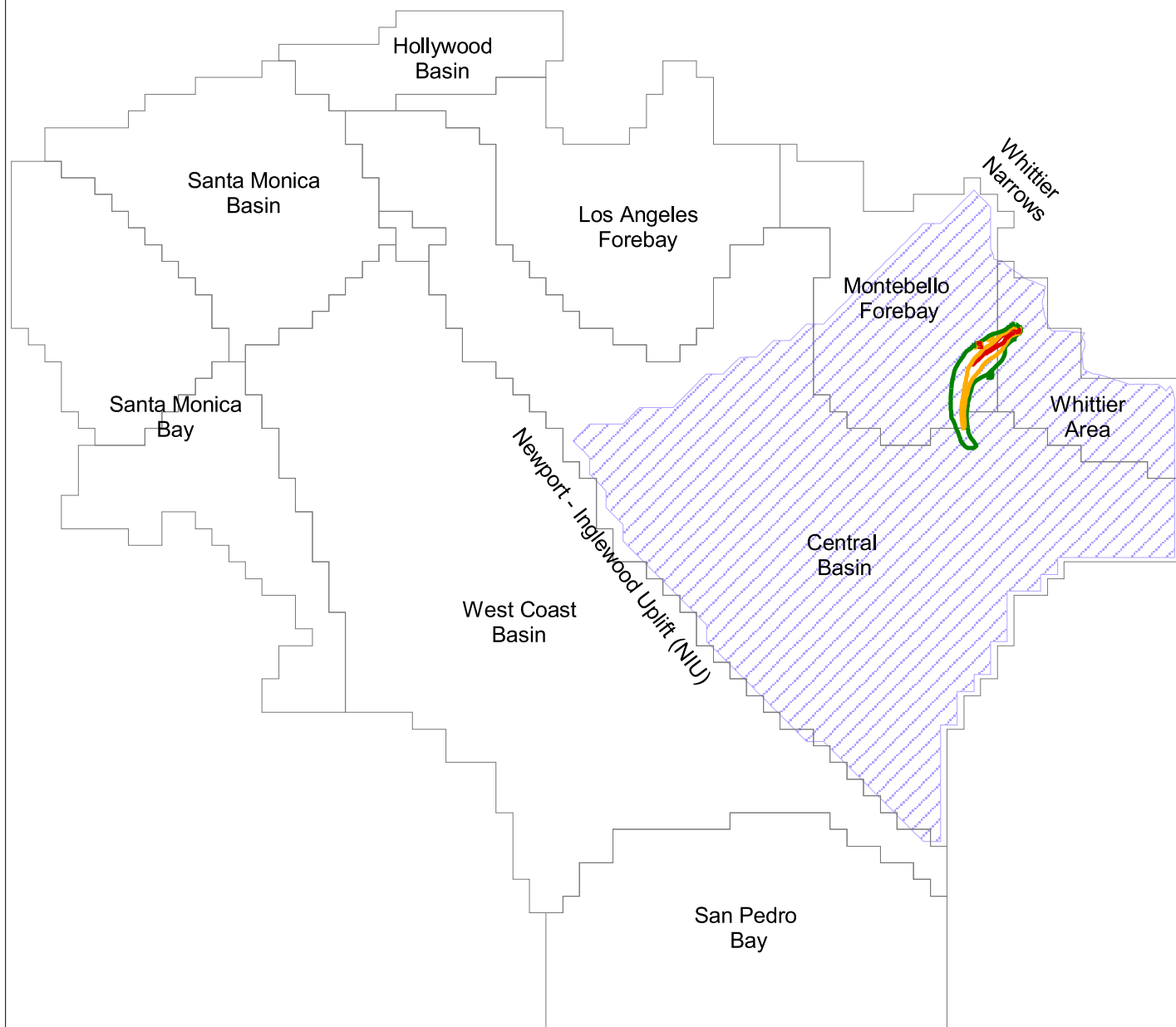
Omega Wells - MW1A&B, MW2, MW3, MW4A-C, MW5,MW6,MW7,MW8A-D,MW9A-B,MW10,MW11,MW12,MW13A-B,MW14  
 MW15,MW16A-C,MW17A-C,MW18A-C,MW19,MW20A-C,MW21,MW22,MW23B-D,OW1A-B,OW2,OW3A-B,OW4A-B,  
 Other Facility Wells - Mckesson\_MW7,Pbibrotech\_MW3,OFRP-MW4,OFRP-MW5,OFRP-MW8,OFRP-MW12,OFRP-MW19,OFRP-MW21.  
 Regional Wells - 10085, 200376, 200556, 200589, 200955, 201992,



## Appendix A Figures

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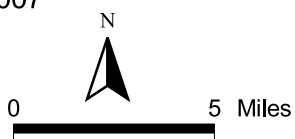




Composite PCE Plume Extent of July, 2007

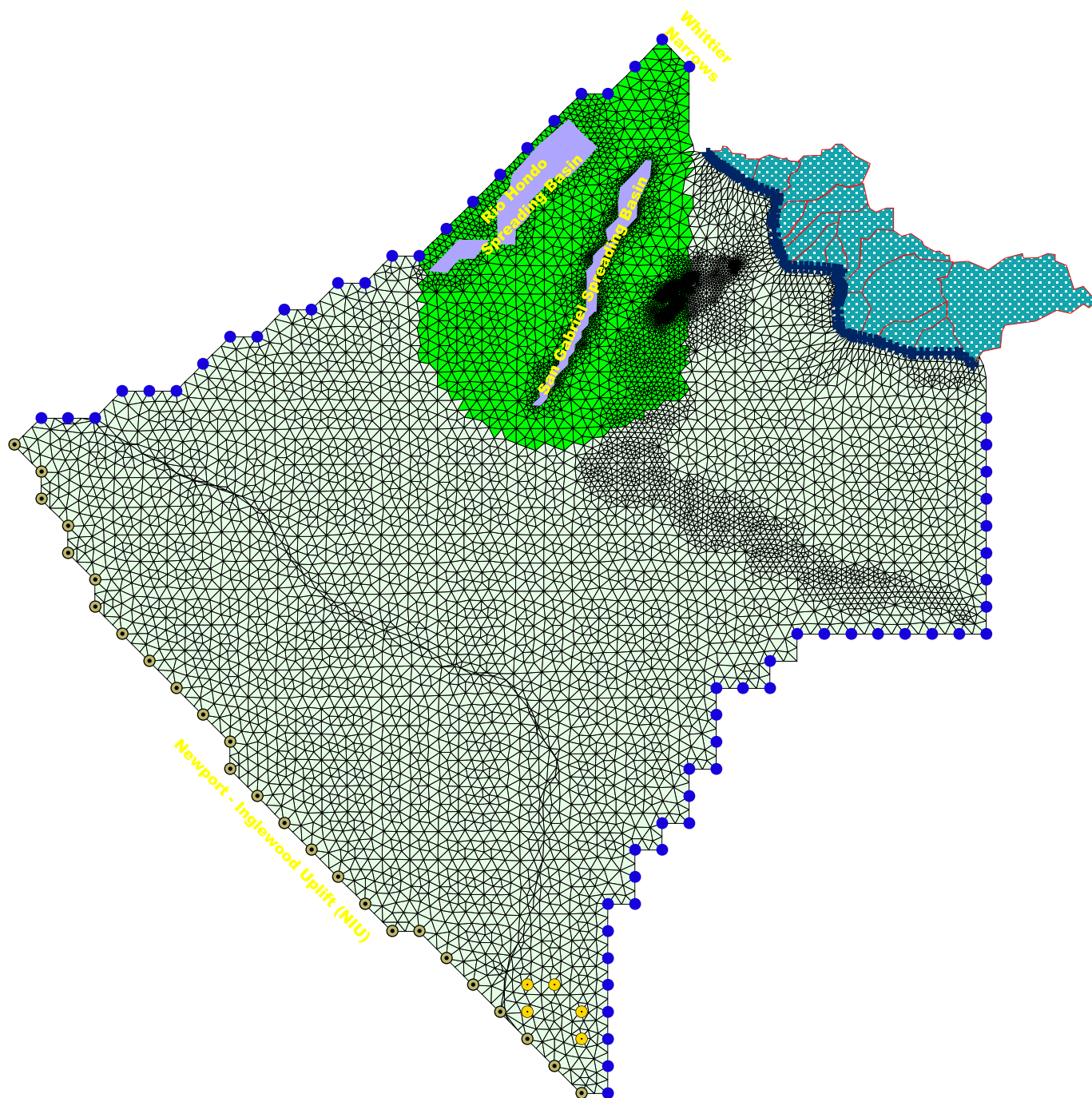
- ▲ 5 ug/L
- ▲ 100 ug/L
- ▲ 500 ug/L










- USGS Model Domain
- Omega Model Domain

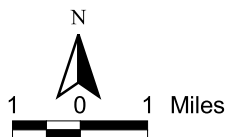


**Figure A-1**  
**Omega Model Domain**  
**Omega OU2 Feasibility Study**



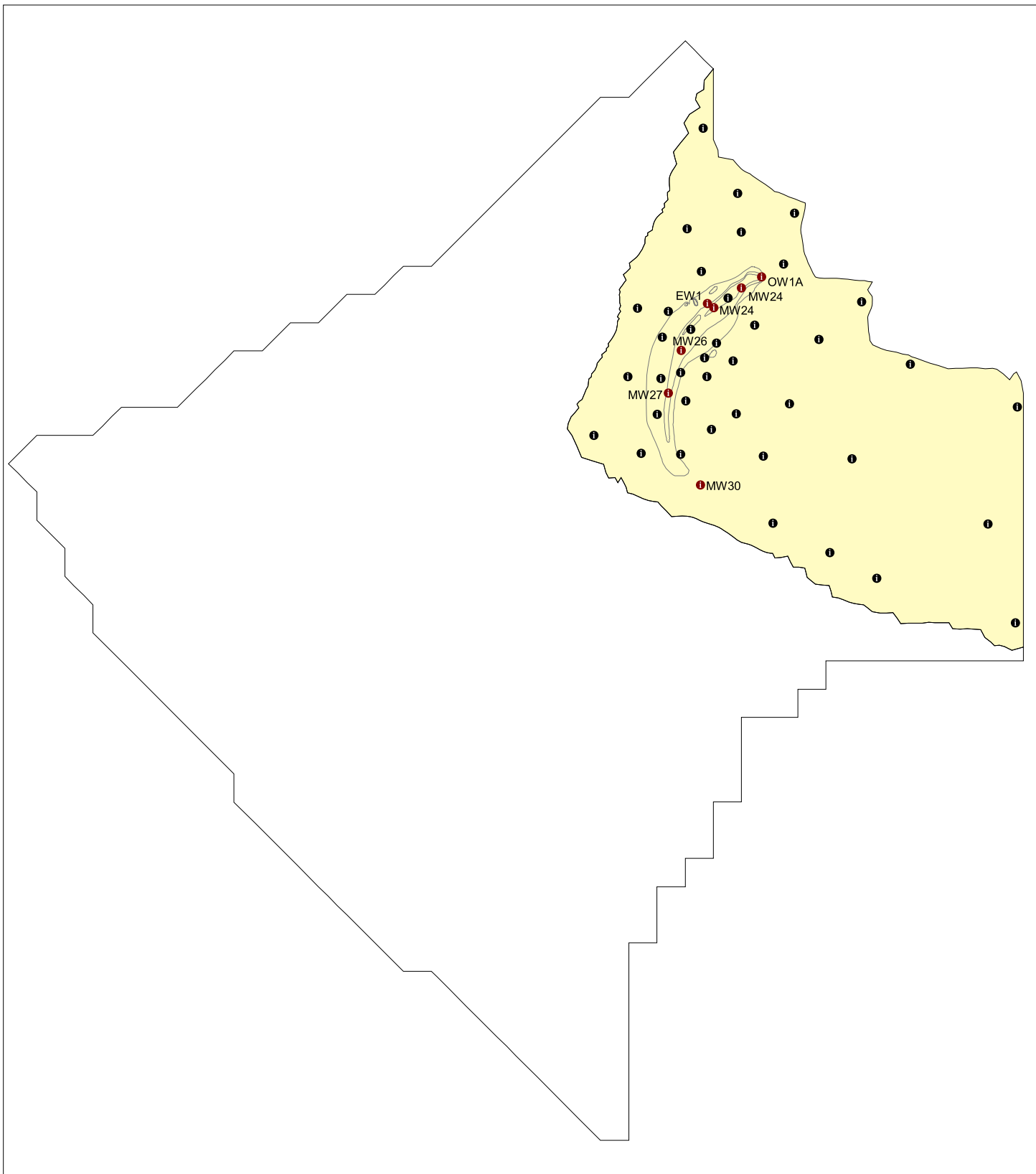







- |   |   |   |  |
|---|---|---|--|
|   | Spreading basins                                      |  | Model nodes representing mountain front recharge |
|   | Omega model mesh                                      |   |  |
|   | Central Basin pressure area                           |   |  |
|   | Montebello Forebay area                               |   |  |
|   | Area receiving mountain front recharges               |   |  |
|  | Model nodes with specified heads                      |   |  |
|  | Injection wells at the Alamosa Barrier                |   |  |
|  | Model nodes with pumping representing flux across NIU |   |  |

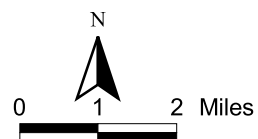


**Figure A-2**  
**Omega Model Boundaries**  
 Omega OU2 Feasibility Study



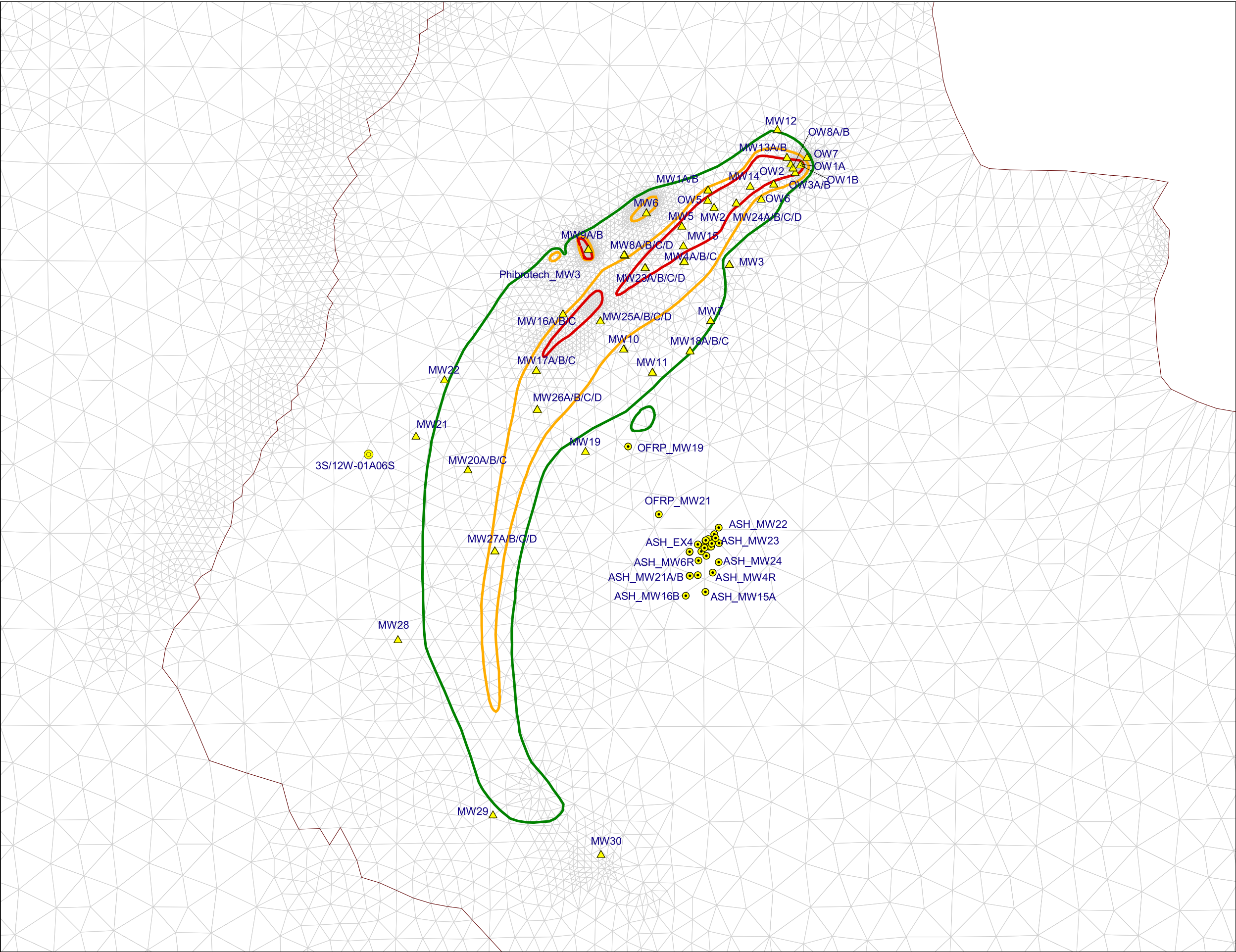


-  Composite PCE Plume Extent  
 Omega Model Domain  
 Area where parameters are adjusted during calibration  
**PEST Pilot Point**  
 with Estimated Hydraulic Conductivity  
 without Estimated Hydraulic Conductivity



**Figure A-3**  
**PEST Pilot Point Distribution**  
**Omega OU2 Feasibility Study**



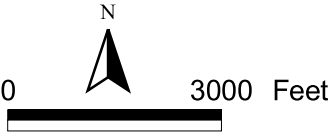


**Explanation**

- ▲ Omega monitoring wells
- Other monitoring wells
- Regional monitoring wells
- Omega Model Mesh
- Area where parameters are adjusted during calibration

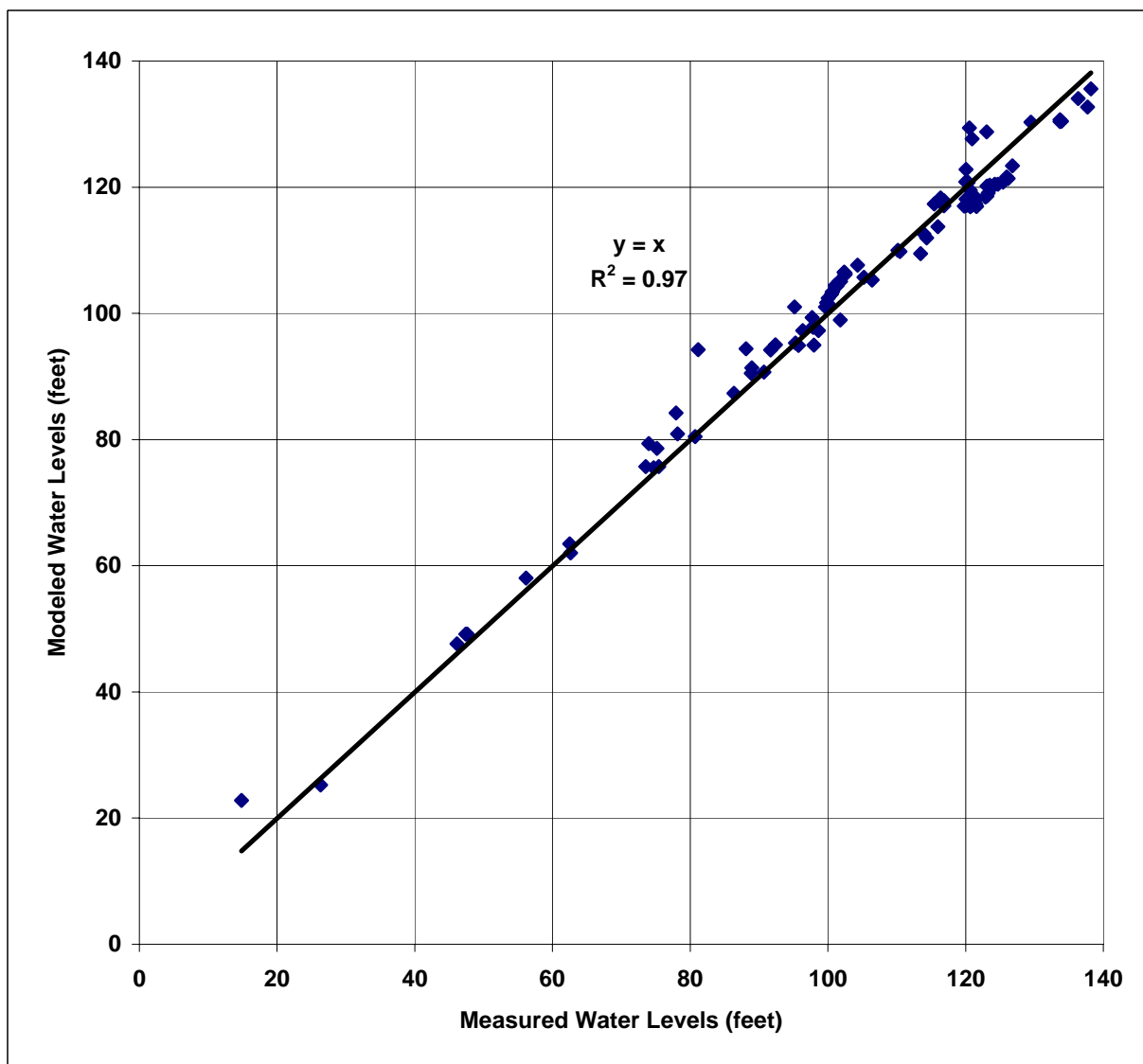
Composite PCE Plume Extent,  
July 2007

- 5 ug/L
- 100 ug/L
- 500 ug/L



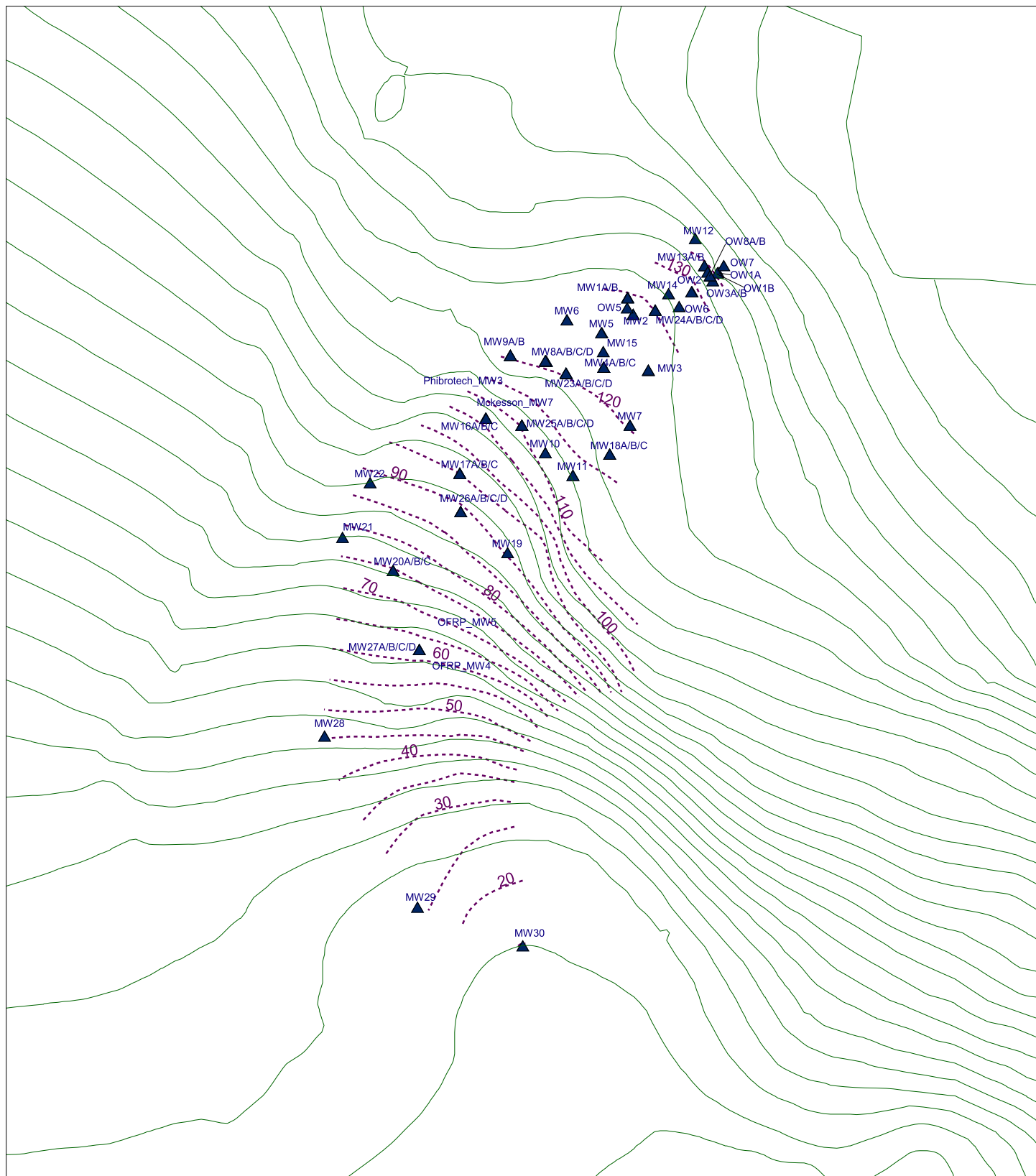
**Figure A-4**  
**Locations of Calibration Wells**  
**Steady-State Model**  
**Omega OU2 Feasibility Study**





**Figure A-5**  
**Scatter Plot of Modeled and Measured Water Levels**  
**Steady-State Model Calibration**  
Omega OU2 Feasibility Study



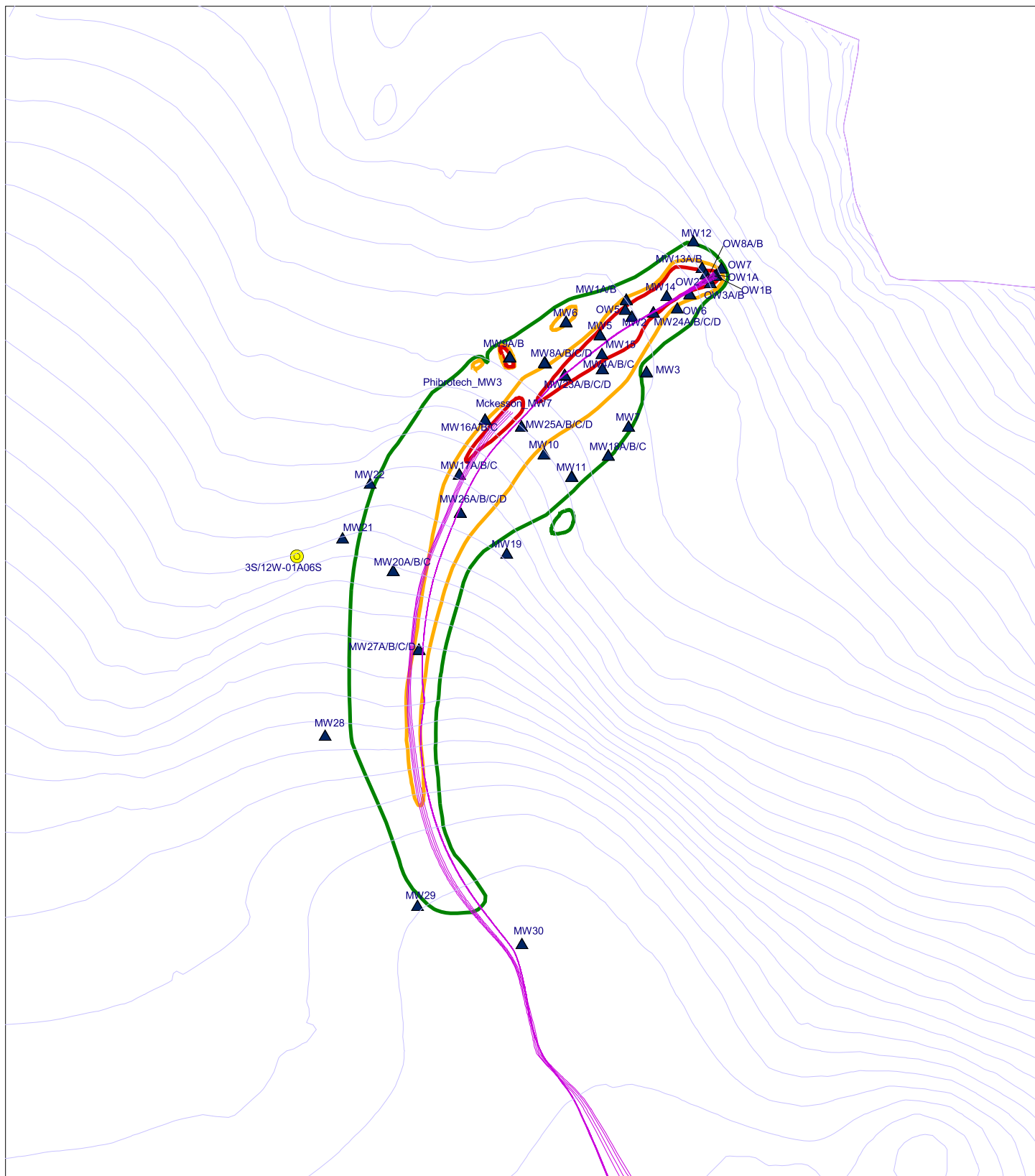


▲ Omega Monitoring Wells  
 Water Table Contours (feet above mean sea level)  
 — Simulated  
 - - - Observed



**Figure A-6**  
**Simulated and Observed Water Table Contours**  
**Steady-State Model Calibration**  
 Omega OU2 Feasibility Study



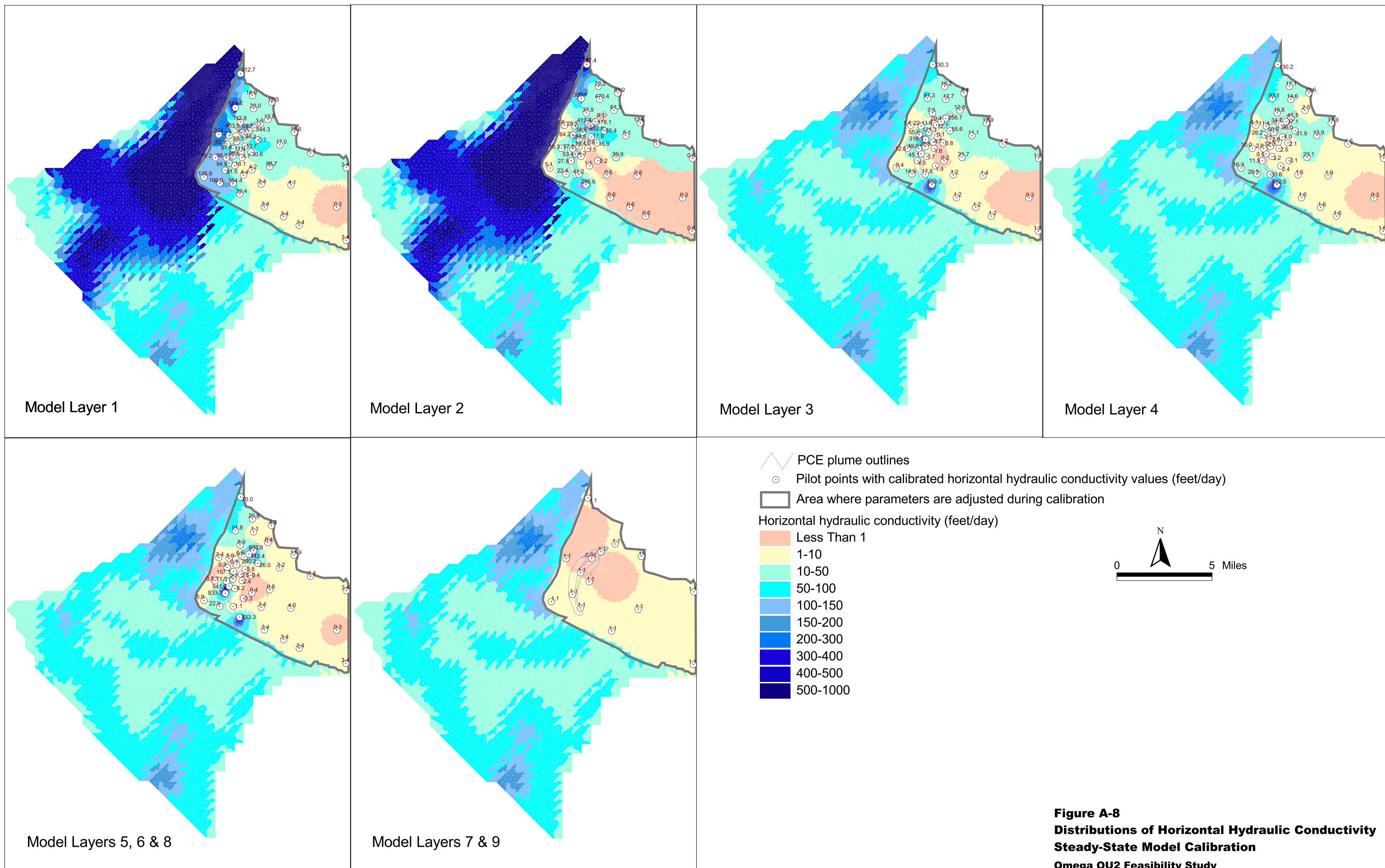


- ▲ Omega Monitoring Wells
- ~ Simulated water table contours ( 5 ft intervals)
- ~ Model simulated particle pathlines
- Composite PCE Plume Extent of
- July 2007
- 5 ug/L
- 100 ug/L
- 500 ug/L

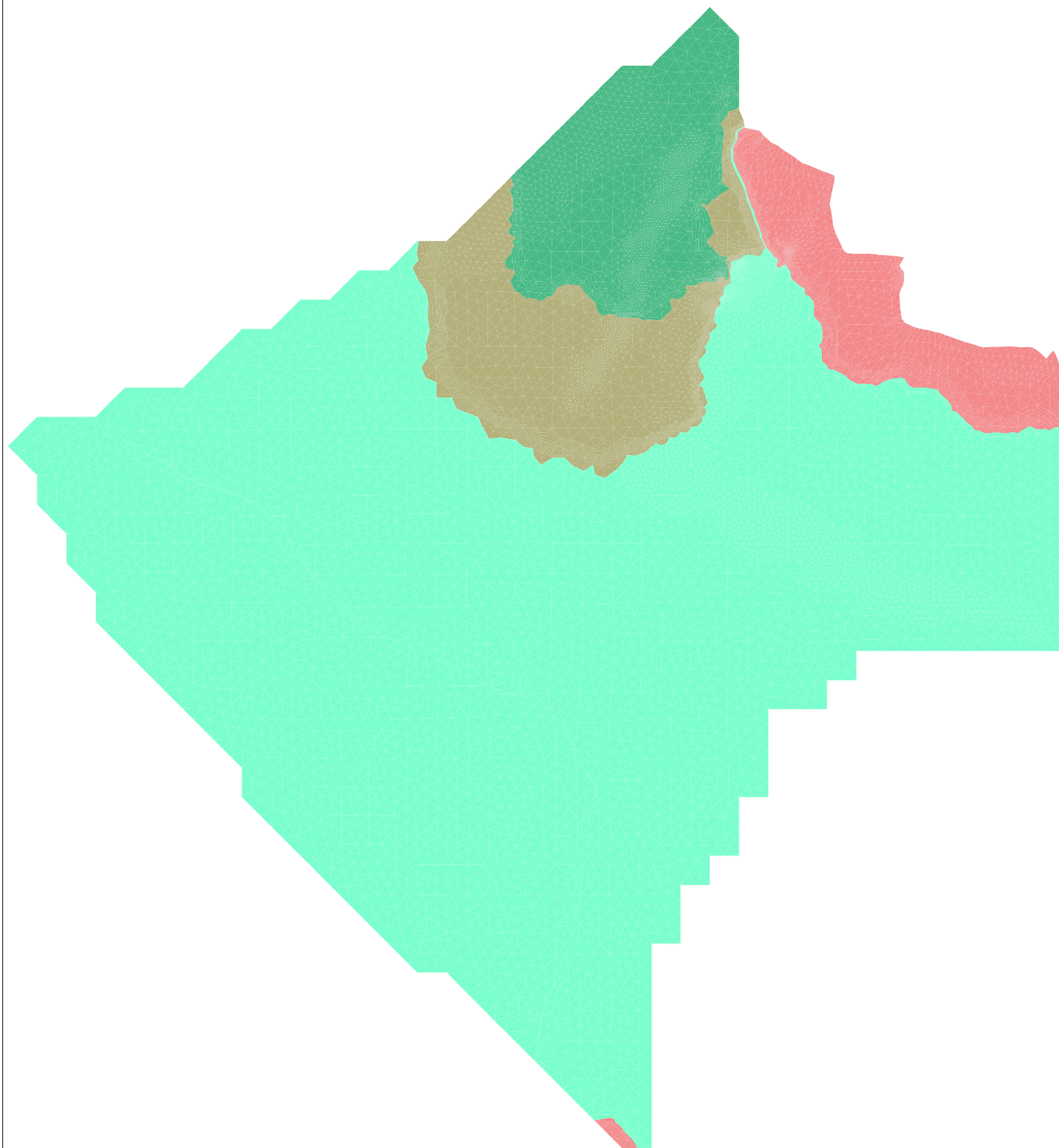


**Figure A-7**  
**Model Simulated Particle Pathlines**  
**in Comparison with Observed PCE**  
**Plume at Omega OU2**  
**Steady-State Model Calibration**  
 Omega OU2 Feasibility Study

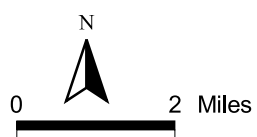
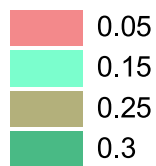






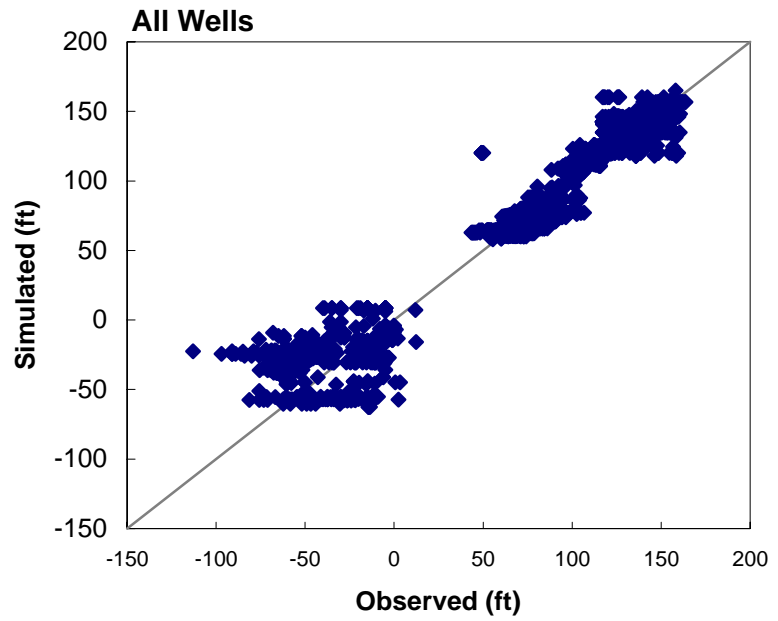
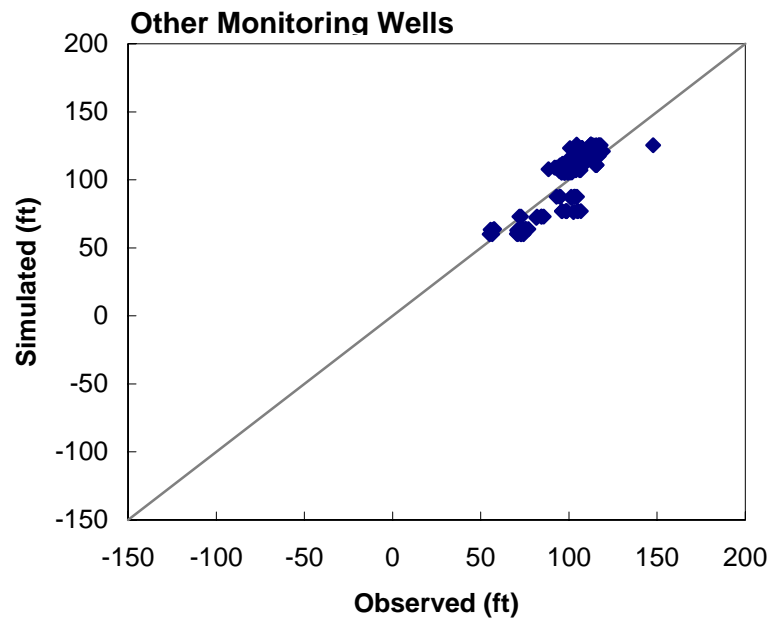
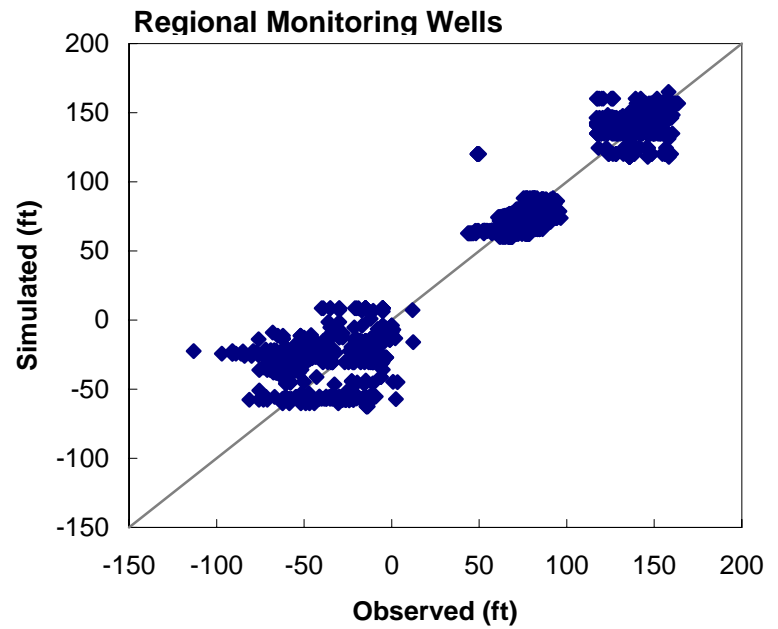
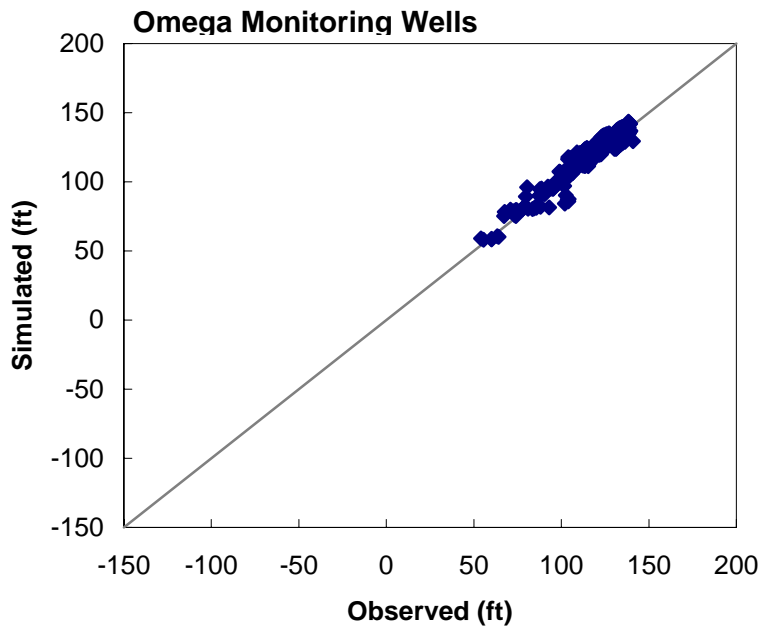


Specific yield



**Figure A-9**  
**Distribution of Specific Yield**  
**Transient Model Simulation**  
Omega OU2 Feasibility Study

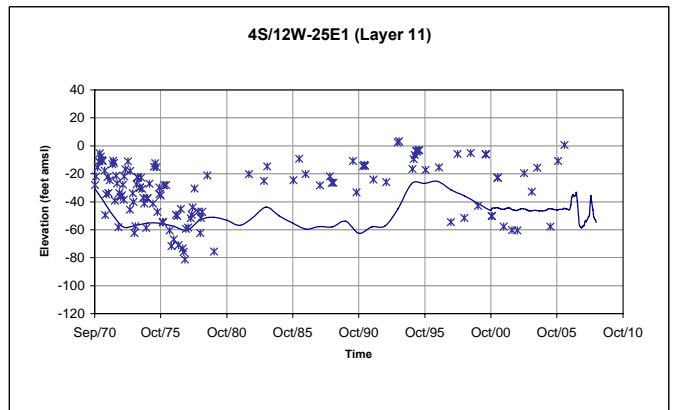
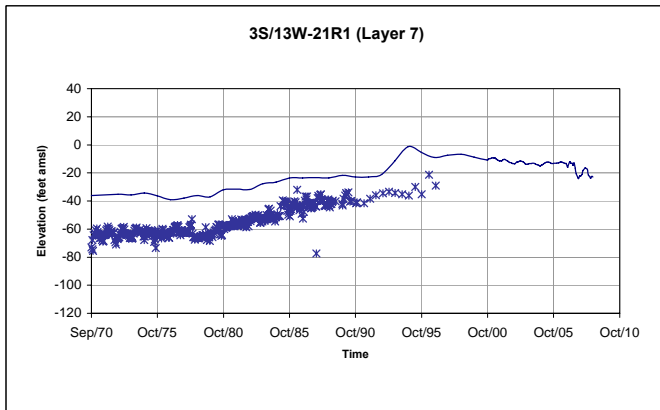
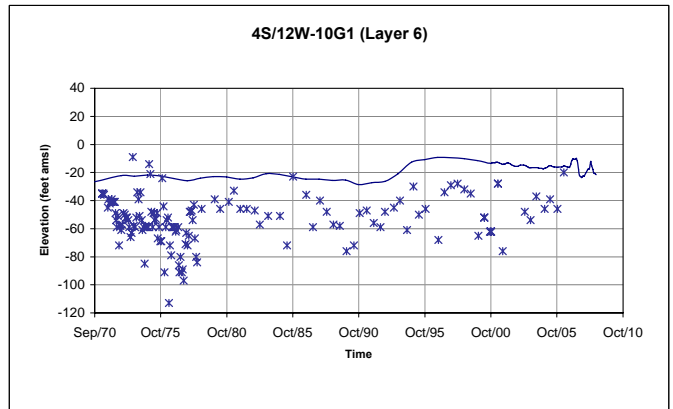
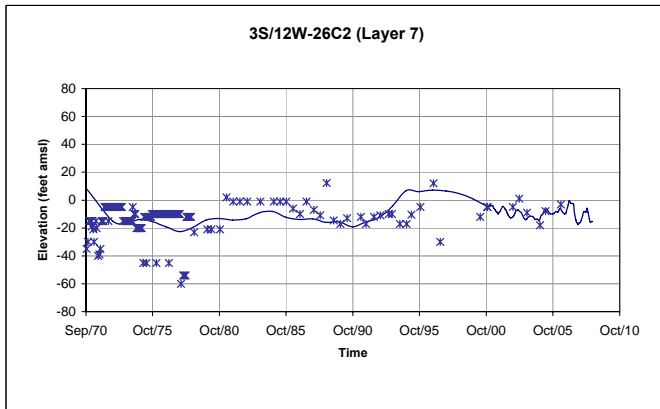
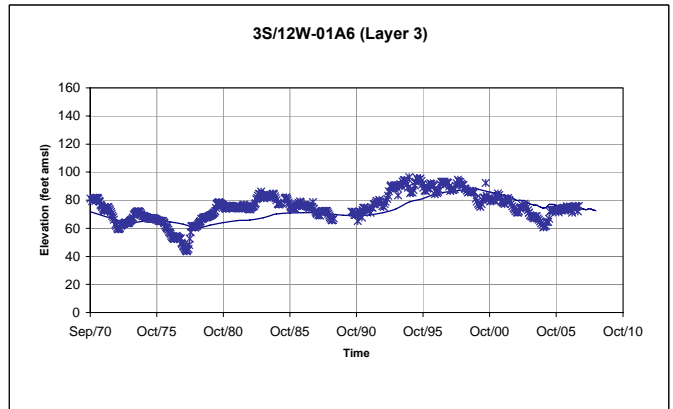
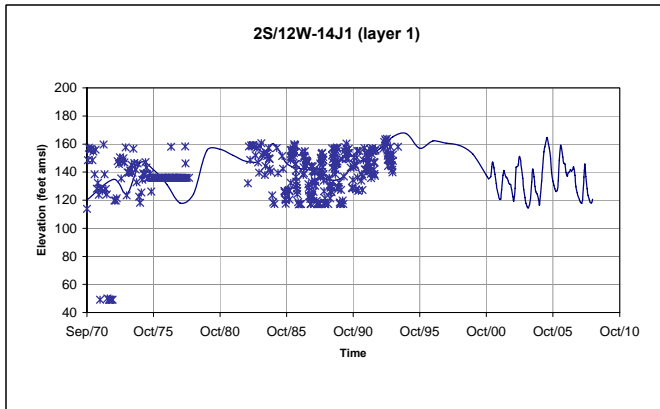




**Figure A-10**

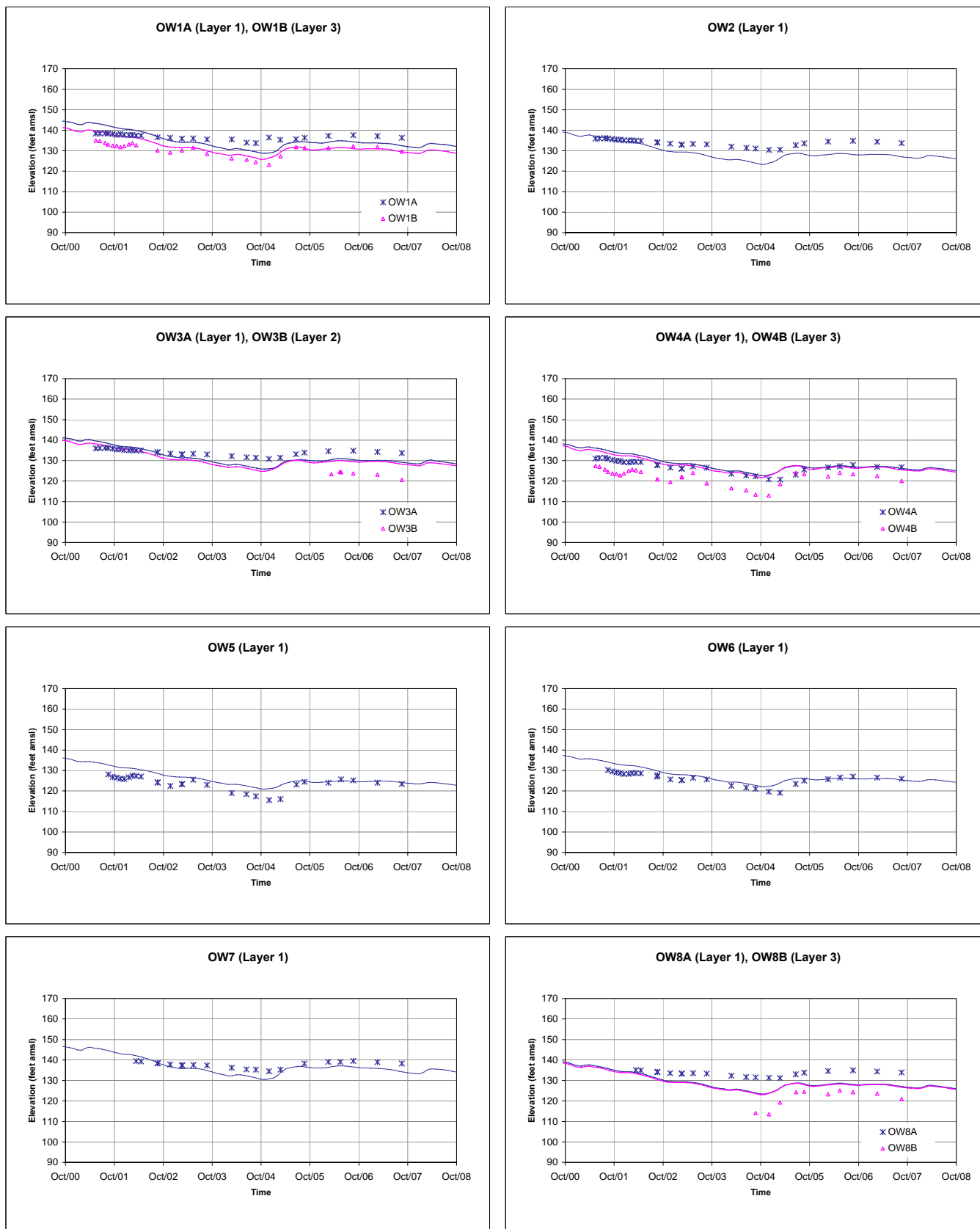
Scatter Plots of Simulated and Measured Water Levels, Transient Model Simulation  
Omega OU2 Feasibility Study





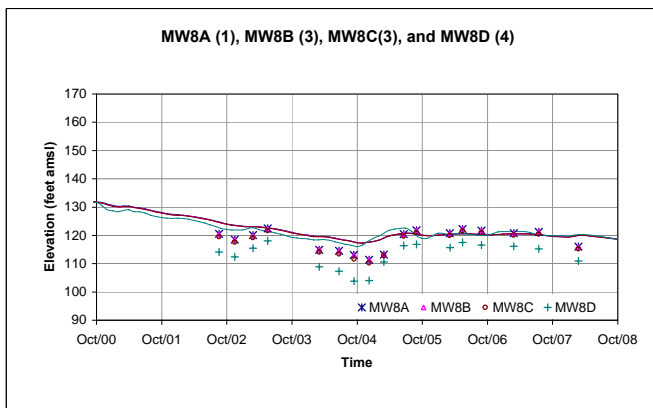
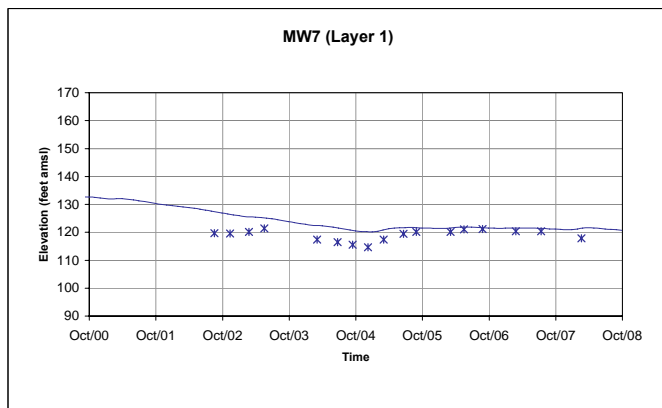
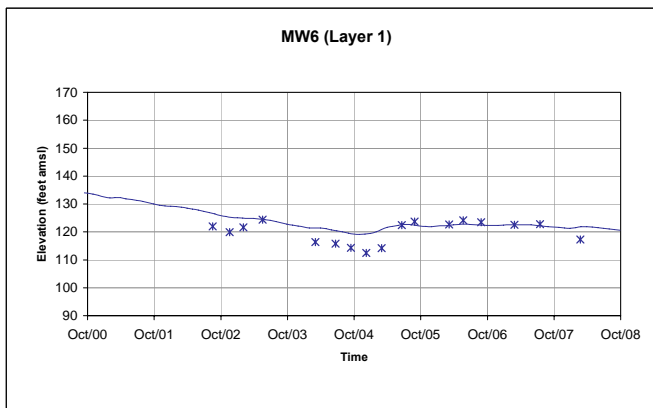
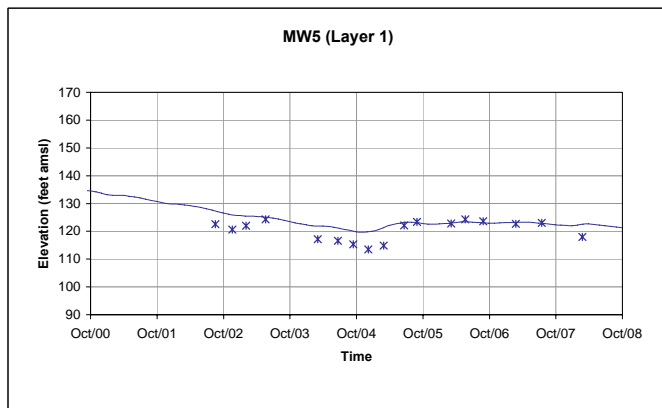
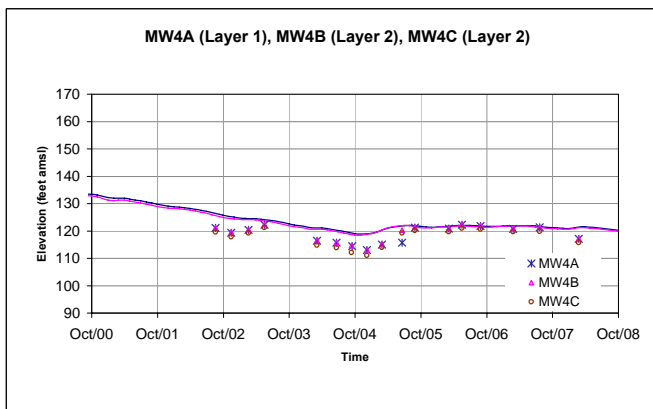
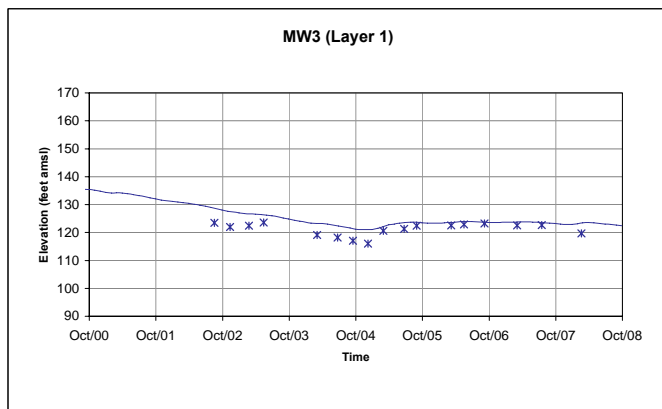
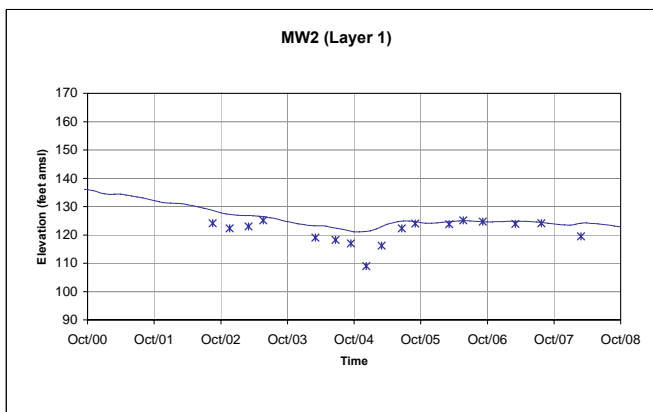
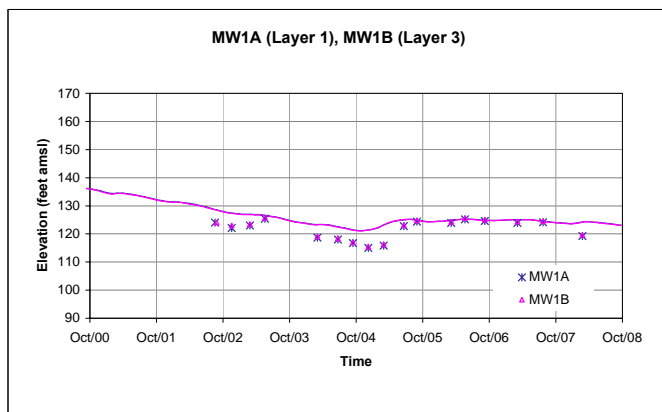
**Figure A-11**  
Hydrographs - Simulated vs Observed  
Omega OU2 Feasibility Study





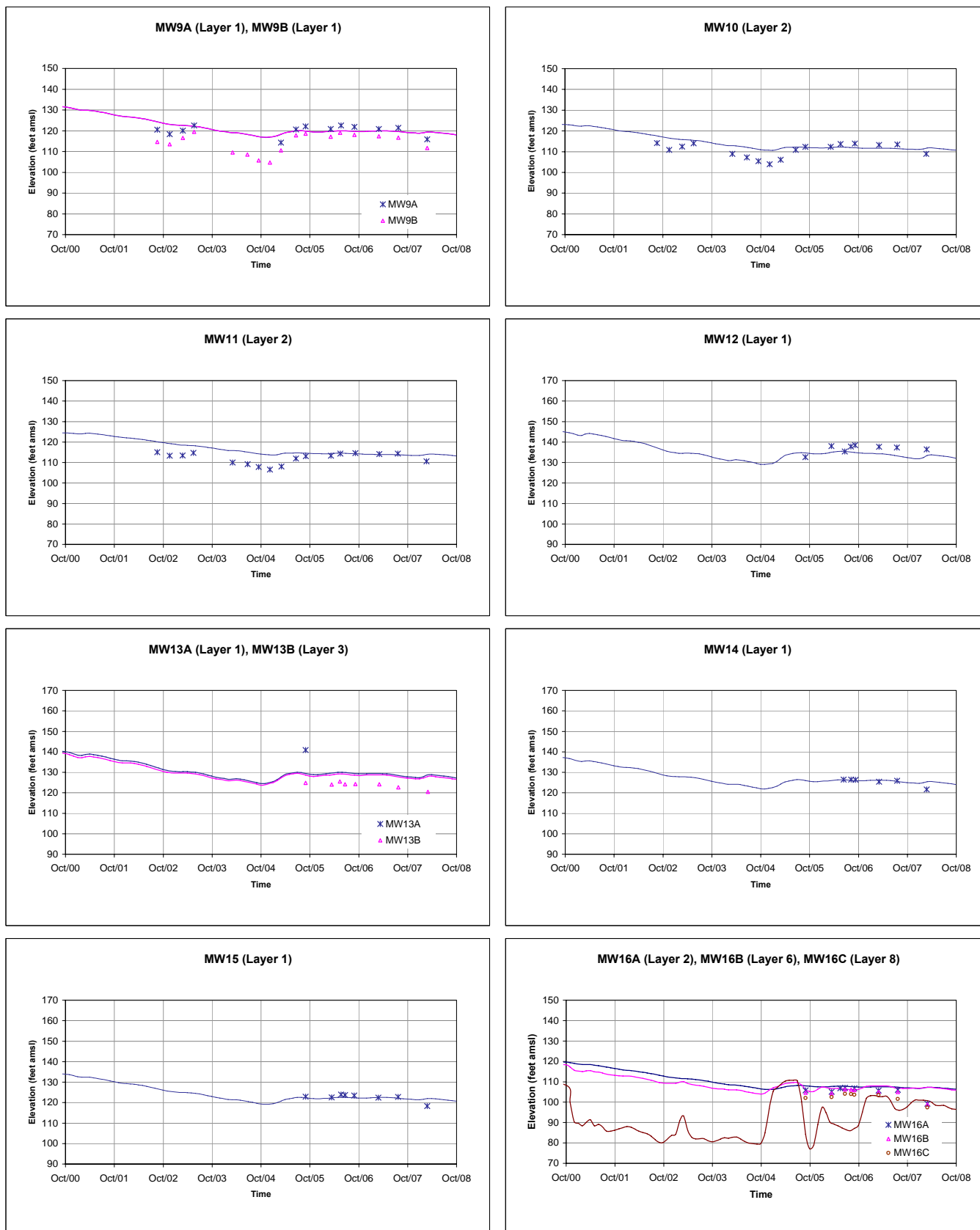
**Figure A-11**  
Hydrographs - Simulated vs Observed  
Omega OU2 Feasibility Study





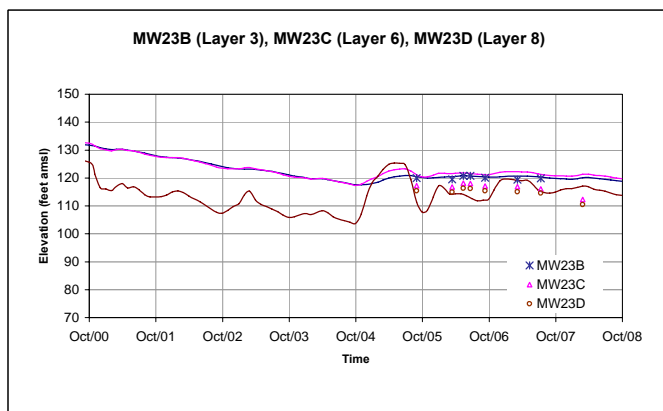
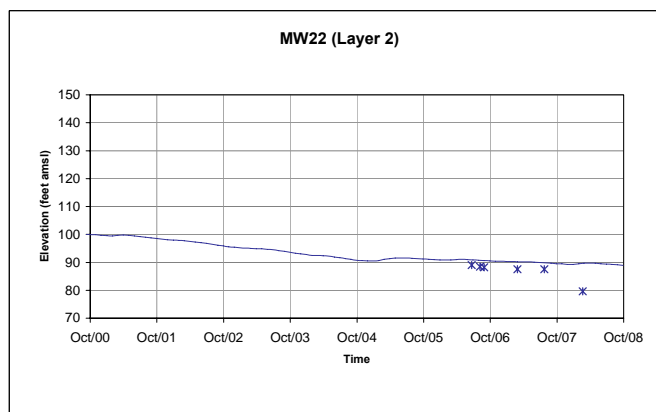
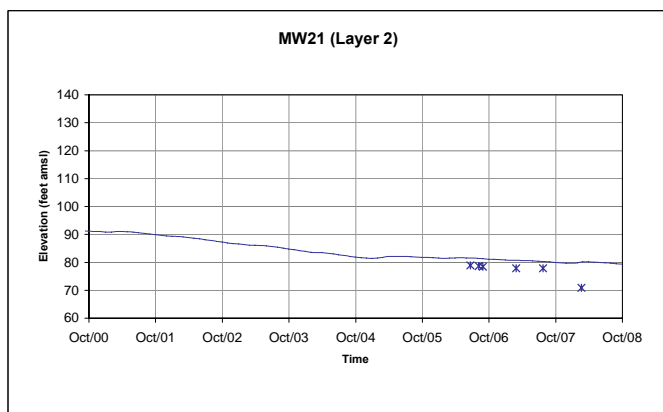
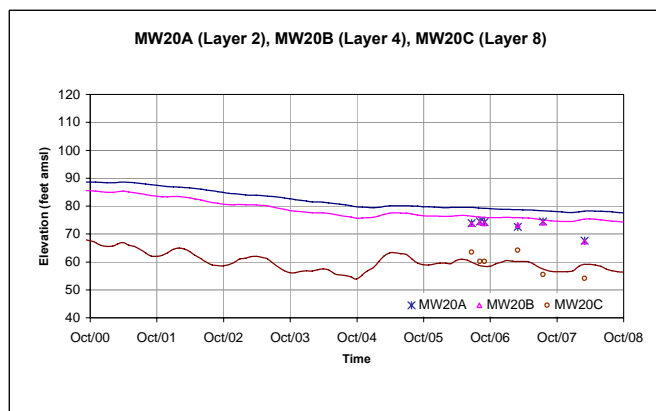
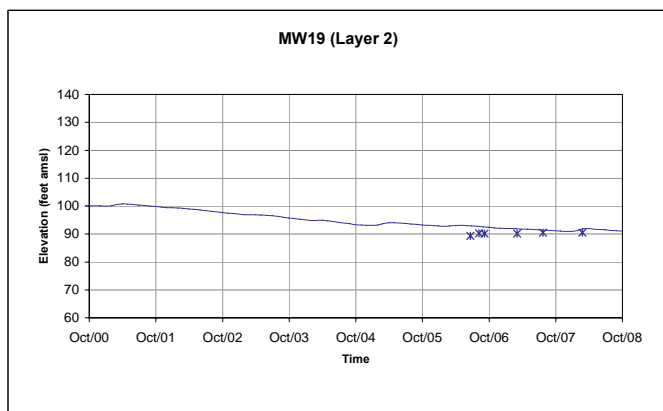
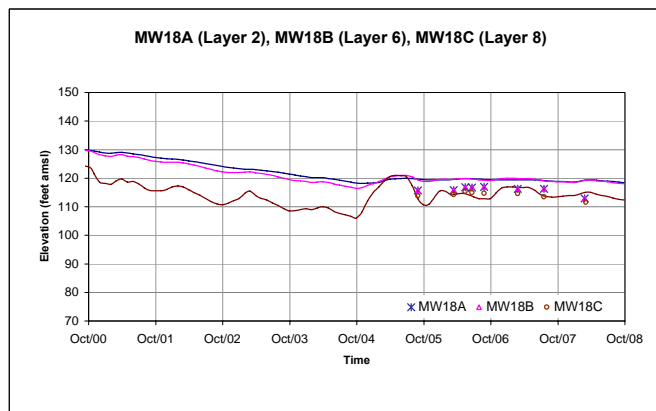
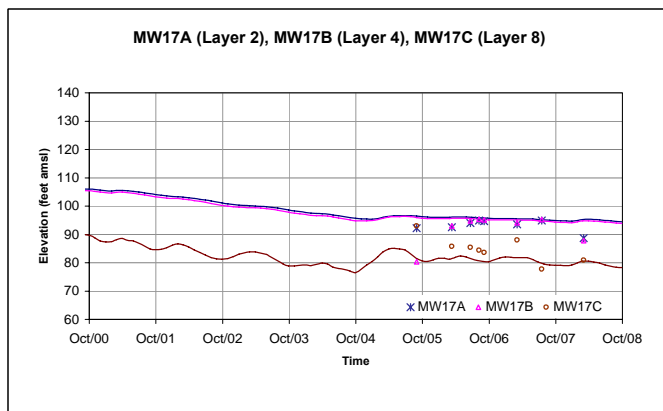
**Figure A-11**  
Hydrographs - Simulated vs Observed  
Omega OU2 Feasibility Study





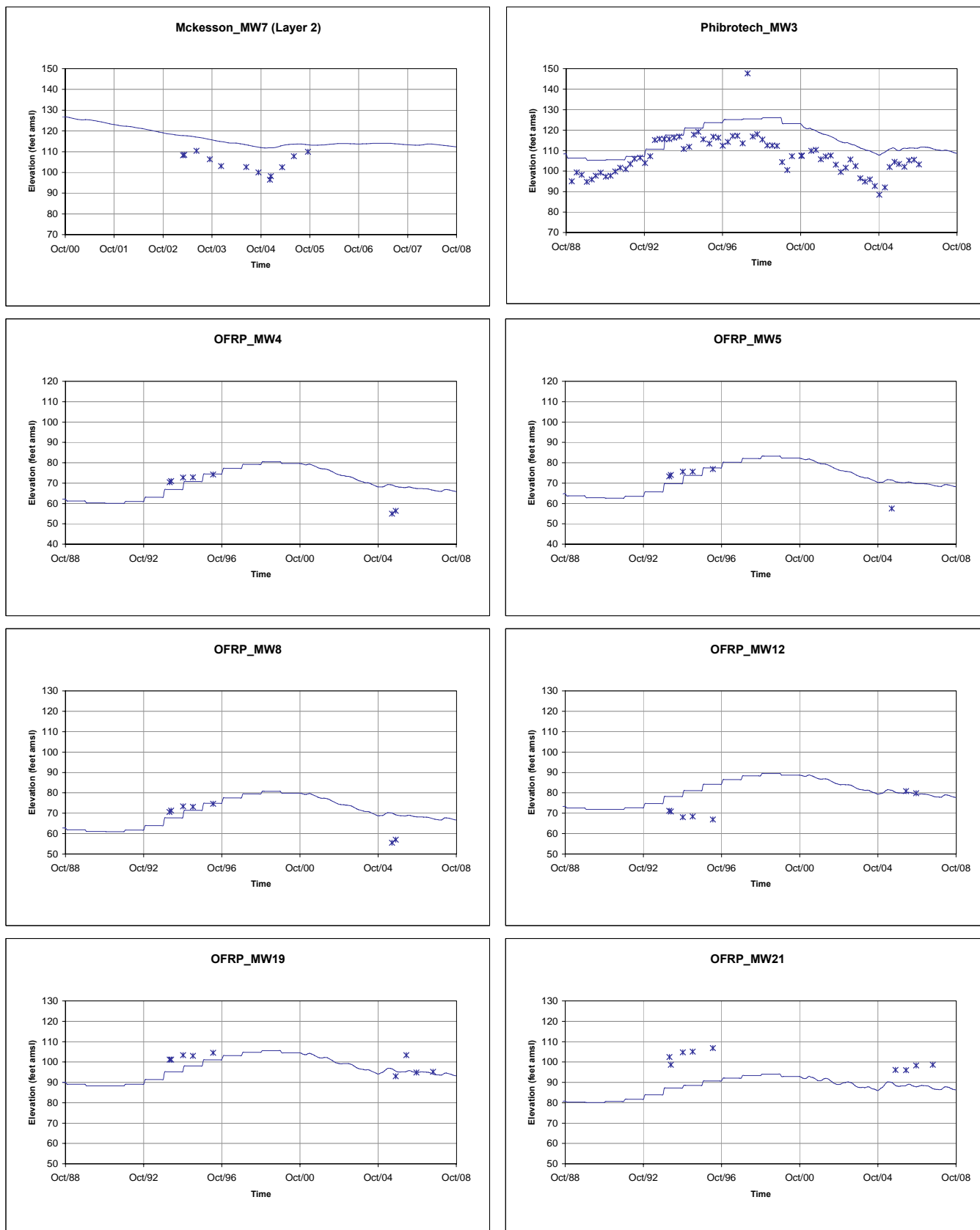
**Figure A-11**  
Hydrographs - Simulated vs Observed  
Omega OU2 Feasibility Study





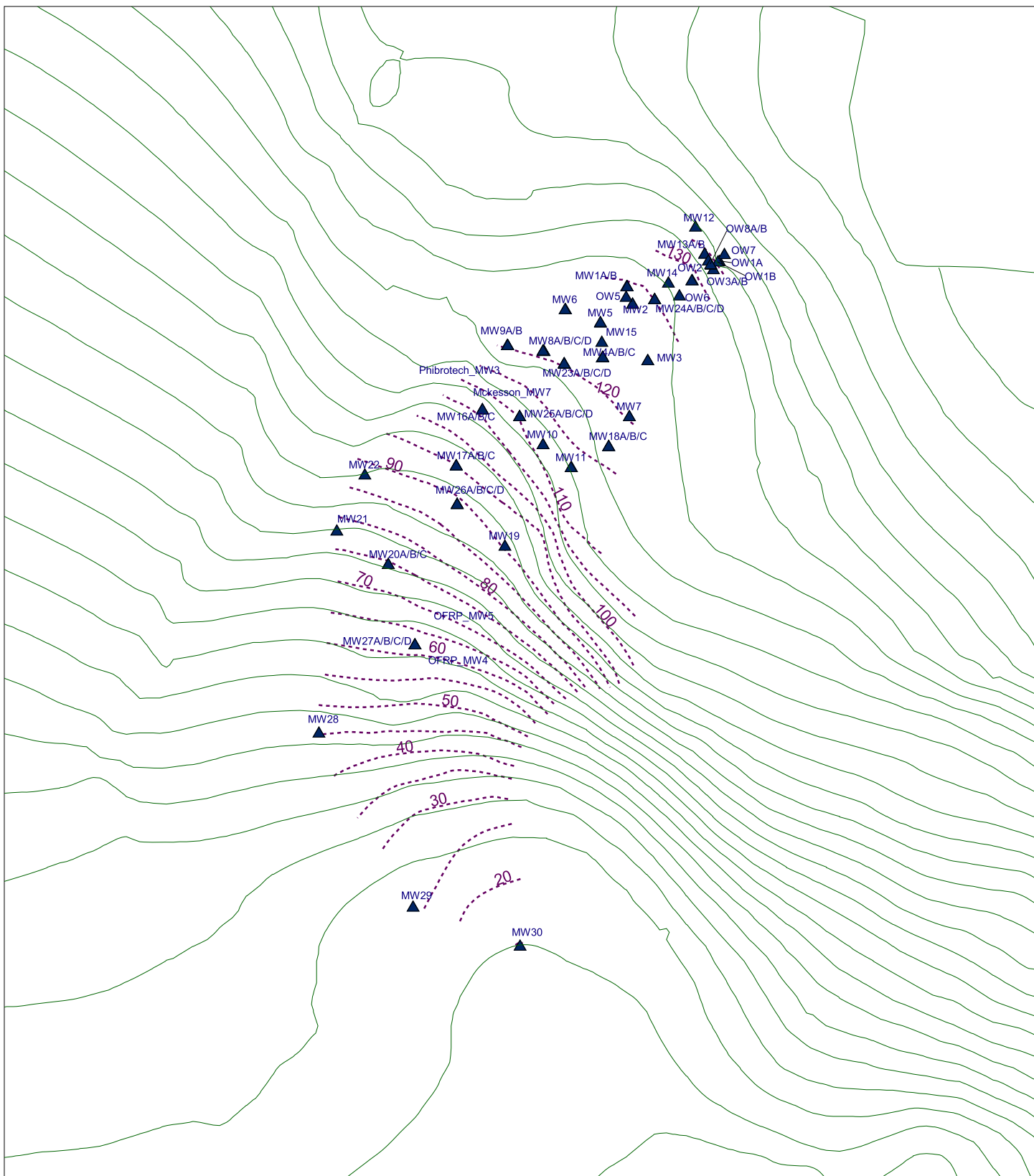
**Figure A-11**  
Hydrographs - Simulated vs Observed  
Omega OU2 Feasibility Study





**Figure A-11**  
 Hydrographs - Simulated vs Observed  
 Omega OU2 Feasibility Study





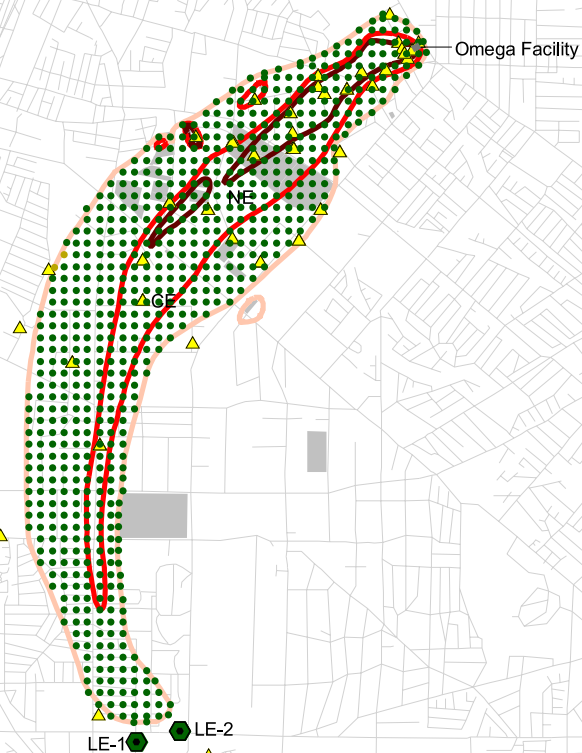
▲ Omega Monitoring Wells  
 Water Table Contours (feet above mean sea level)  
 — Simulated  
 - - - Observed



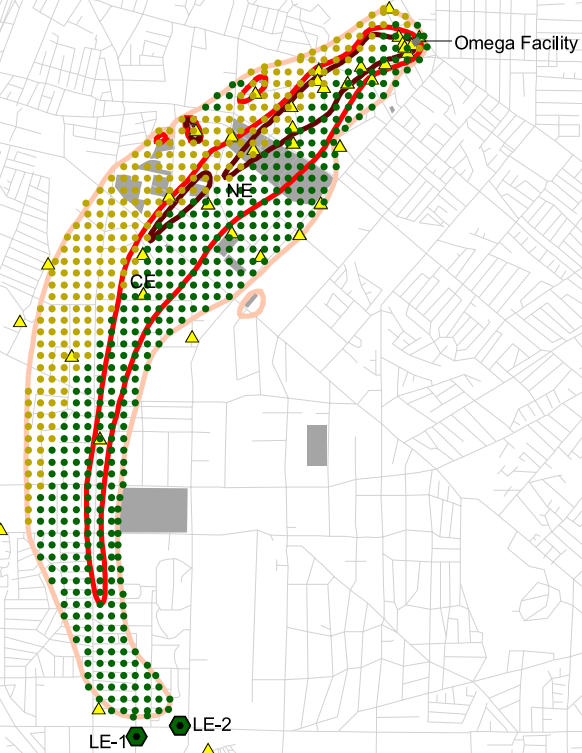
**Figure A-12**  
**Simulated and Observed**  
**Water Table Contours for July 2007**  
**Transient Model Simulation**  
 Omega OU2 Feasibility Study



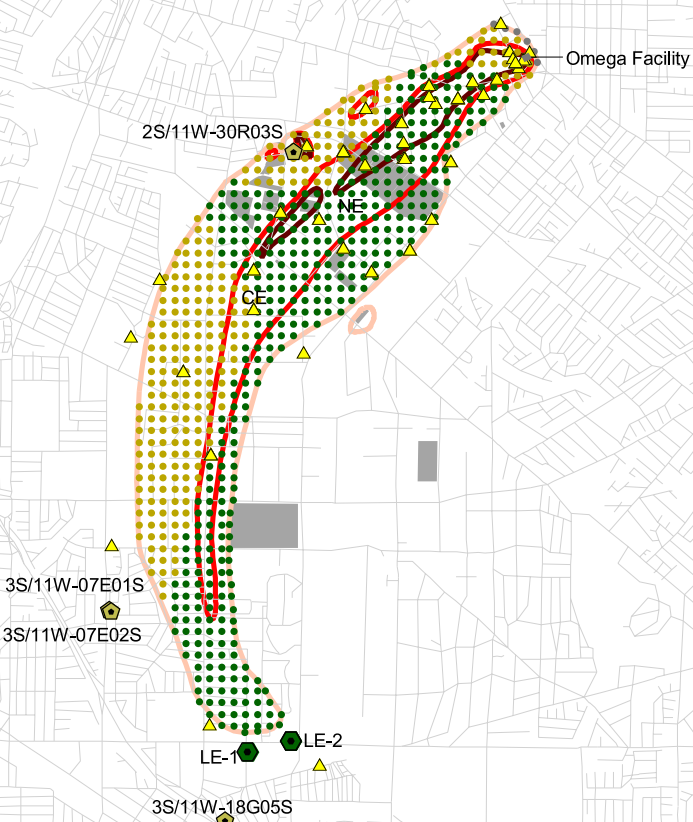
Particles started from upper portion of the aquifer zone where contamination is observed



Particles started from middle portion of the aquifer zone where contamination is observed



Particles started from lower portion of the aquifer zone where contamination is observed



- ▲ Monitoring well
- ▲ Active production well
- Proposed extraction well
- Omega facility
- Other facilities
- Street

Composite PCE plume extents, July 2007

- ▲ 100 ug/L
- ▲ 5 ug/L
- ▲ 500 ug/L

- Particle starting locations
- Escaping particles
  - Captured by active production wells
  - Captured by proposed extraction wells LE-1 or LE-2

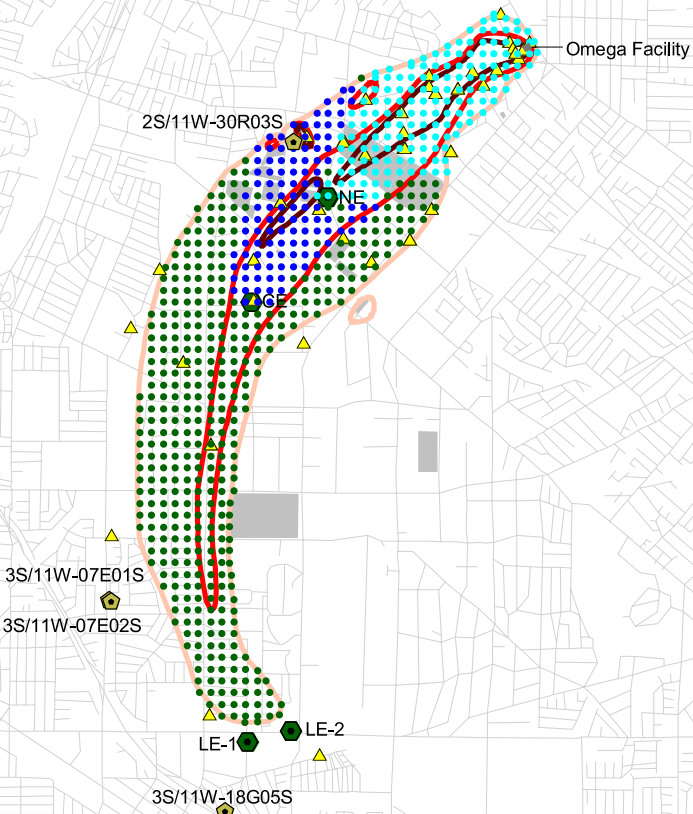
Note:  
Total extraction rate = 1,150 gpm  
LE-1 = 550 gpm  
LE-2 = 600 gpm



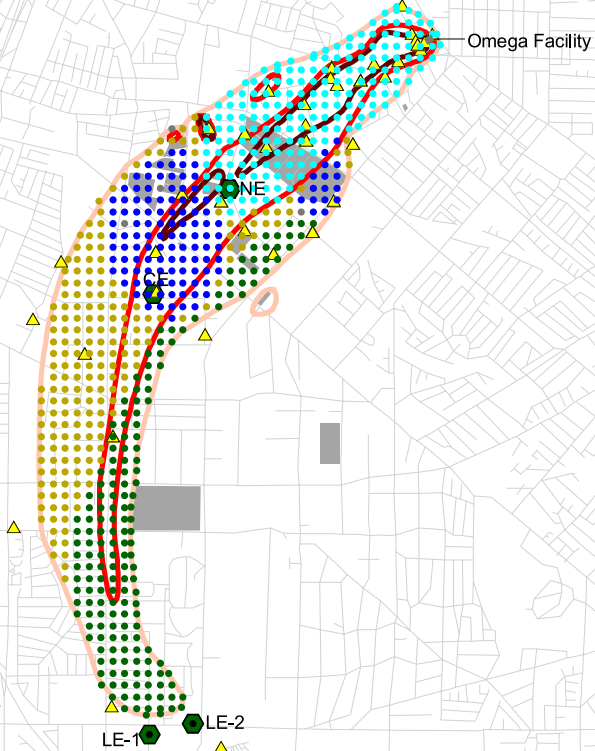
**Figure A-13**  
**Capture Zone Map**  
**Pumping Scenario with Leading Edge Extraction**  
**Omega OU2 Feasibility Study**



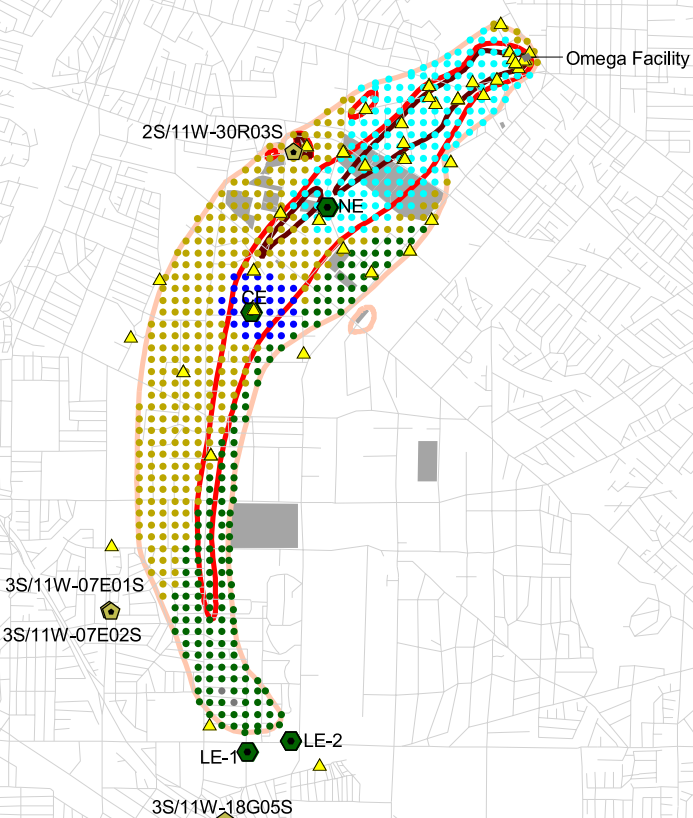
Particles started from upper portion of the aquifer zone where contamination is observed



Particles started from middle portion of the aquifer zone where contamination is observed



Particles started from lower portion of the aquifer zone where contamination is observed



- ▲ Monitoring well
- ◆ Active production well
- ◆ Proposed extraction well
- Omega facility
- Other facilities
- Street

Composite PCE plume extents, July 2007

- ▲ 100 ug/L
- ▲ 5 ug/L
- ▲ 500 ug/L

Particle starting locations

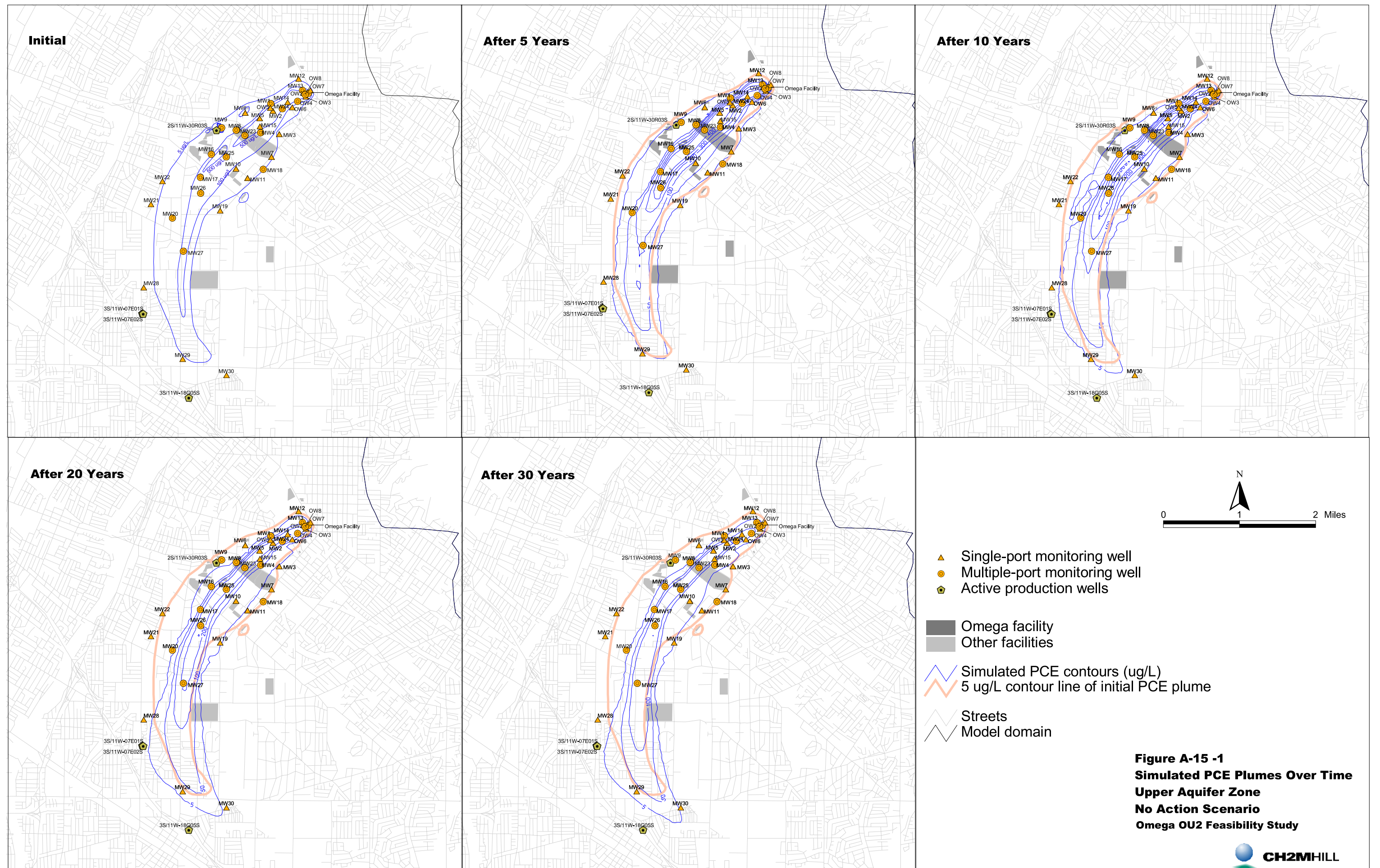
- Escaping particles
- Captured by active production wells
- Captured by proposed extraction wells LE-1 or LE-2
- Captured by proposed extraction well NE
- Captured by proposed extraction well CE

Total extraction rate = 1300 gpm  
LE-1 = 300 gpm  
LE-2 = 350 gpm  
CD = 325 gpm  
NE = 325 gpm



**Figure A-14**  
**Capture Zone Map**  
**Pumping Scenario with Leading Plume-wide Extraction**  
**Omega OU2 Feasibility Study**

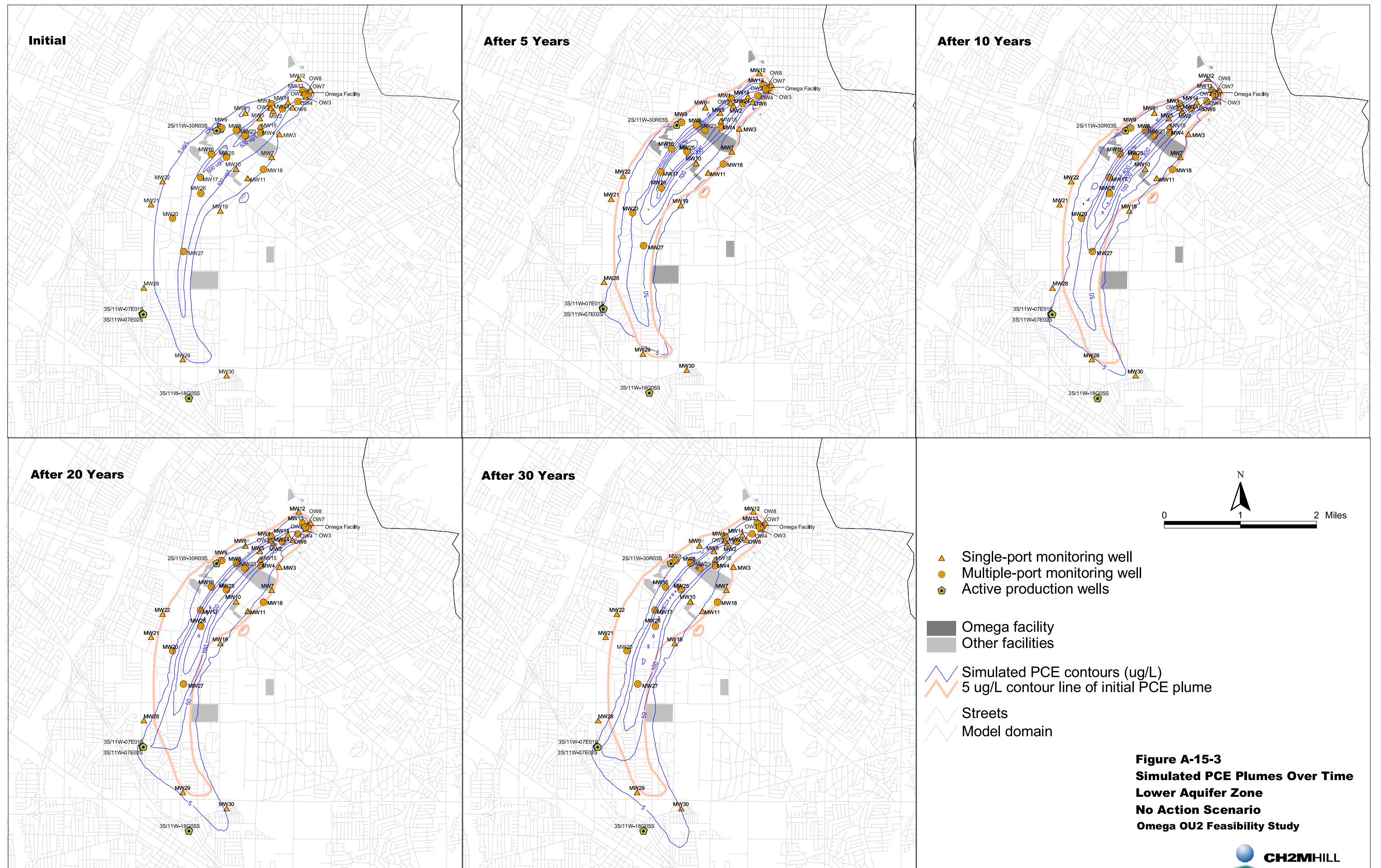




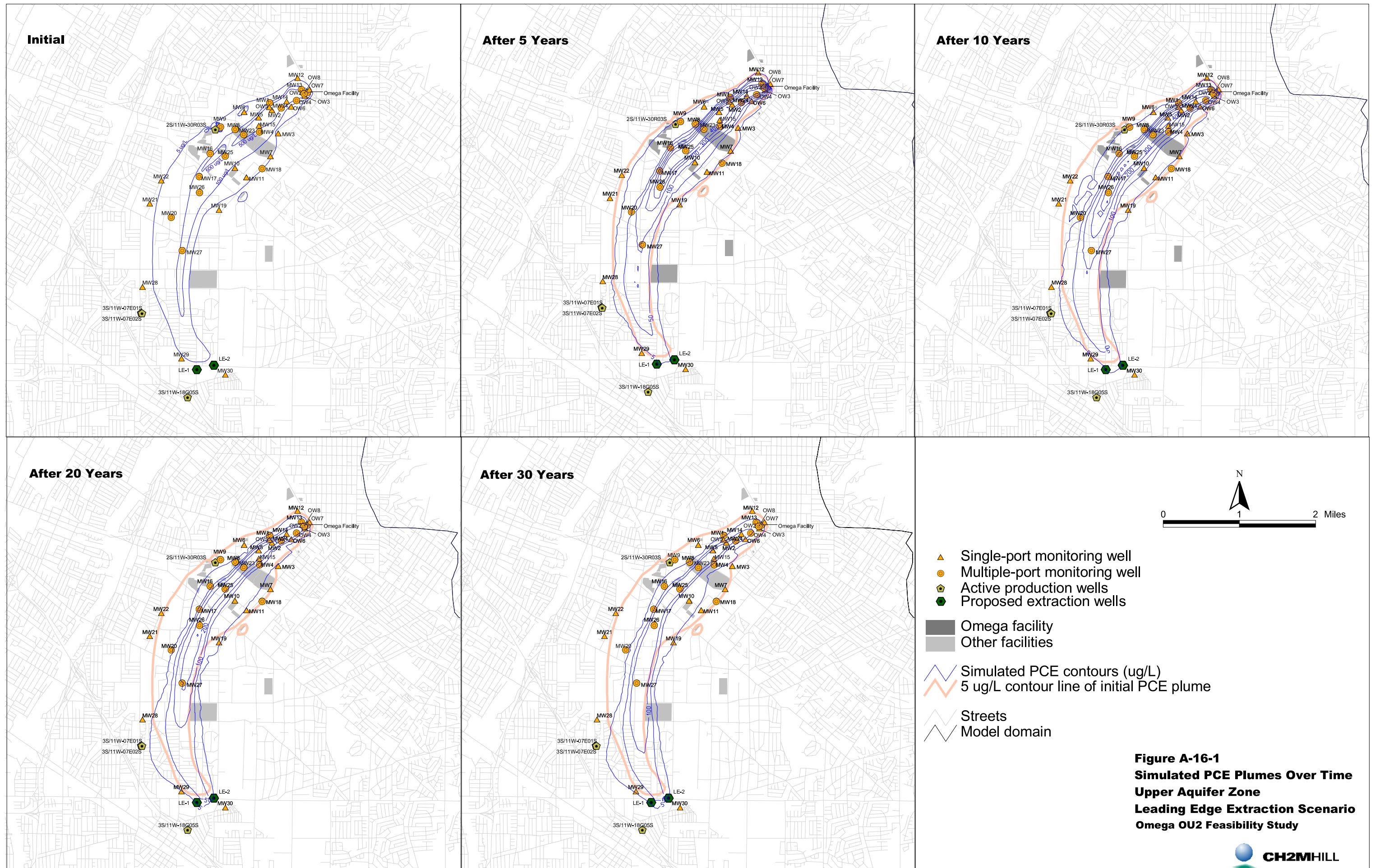




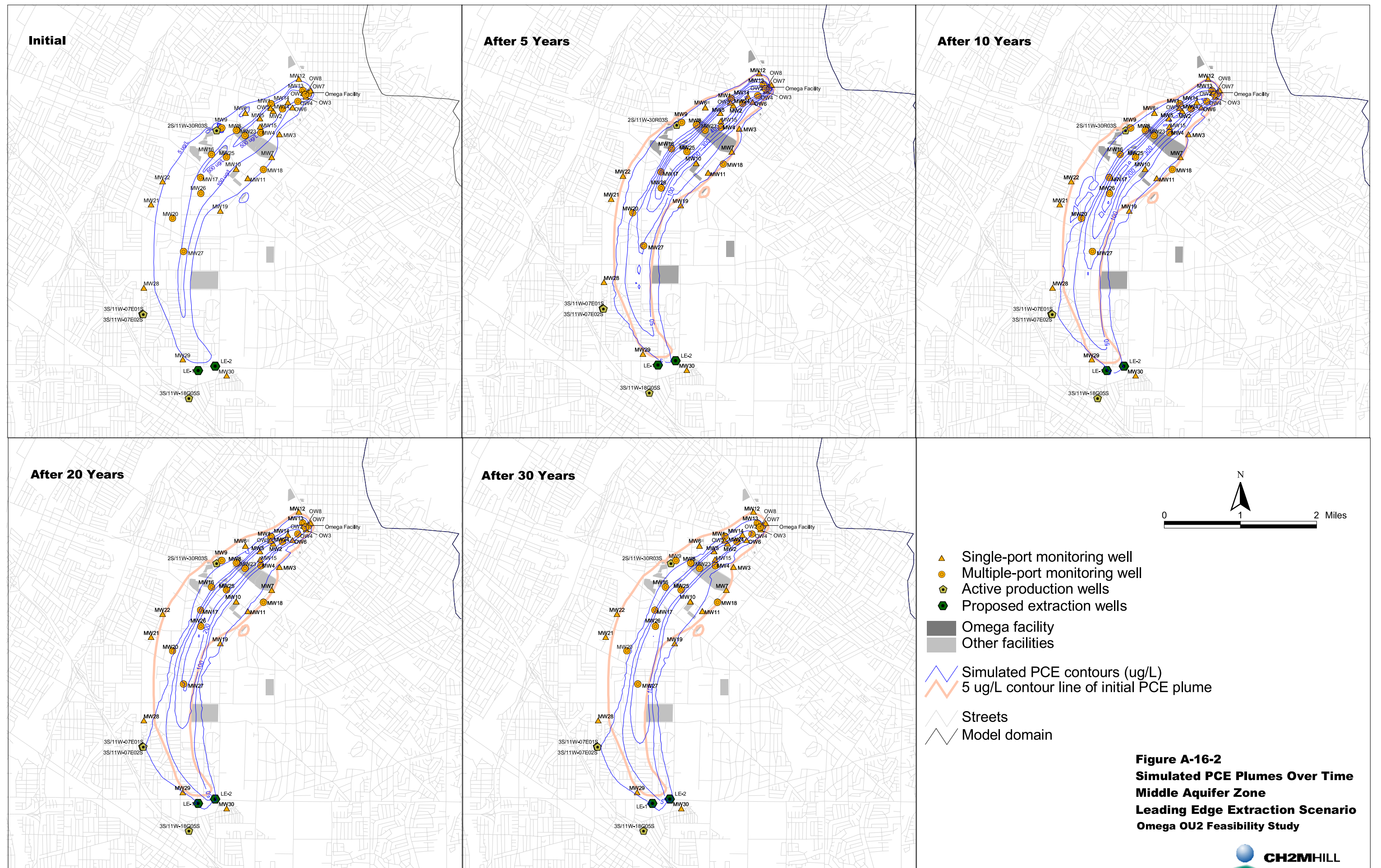




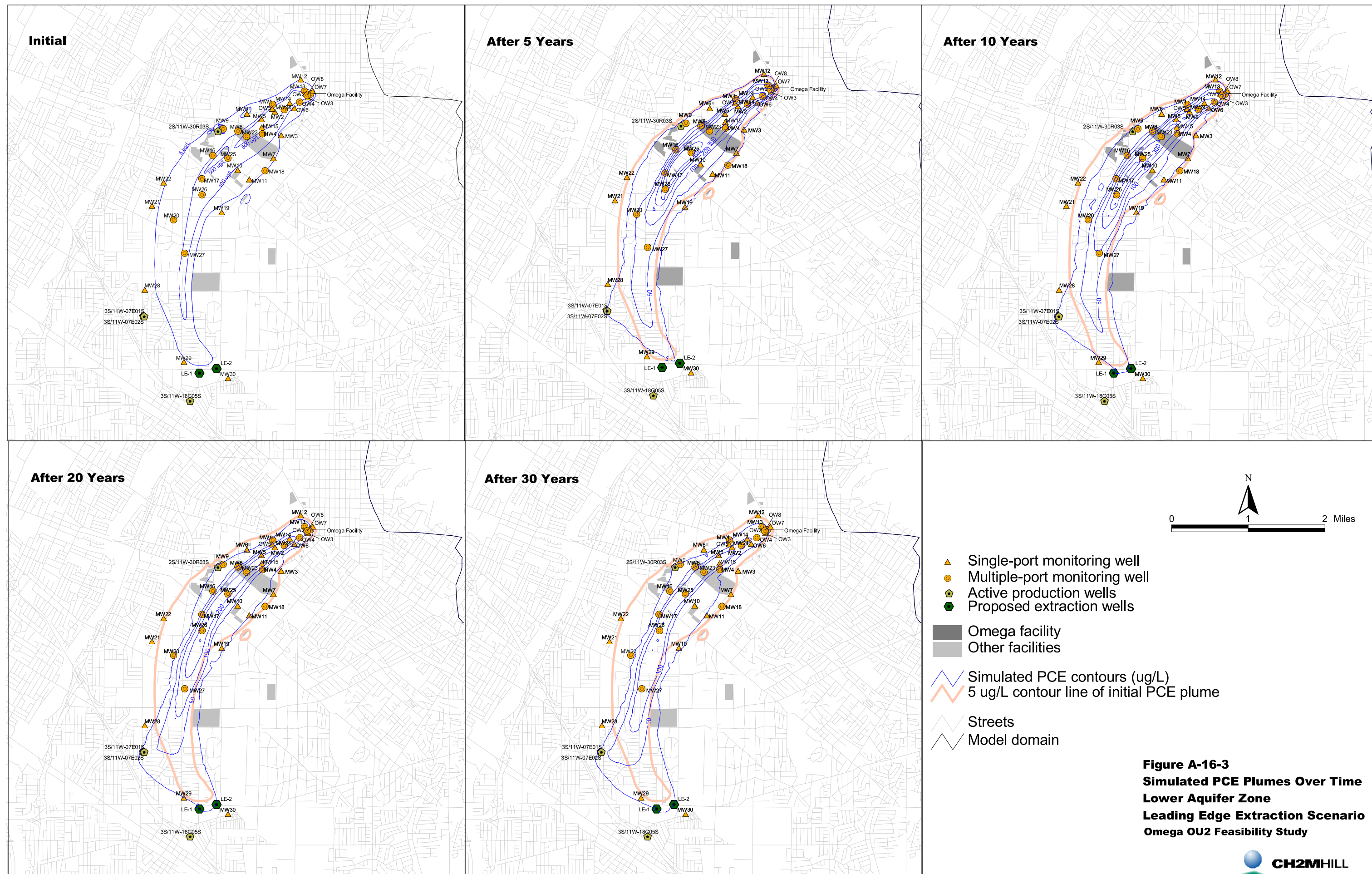




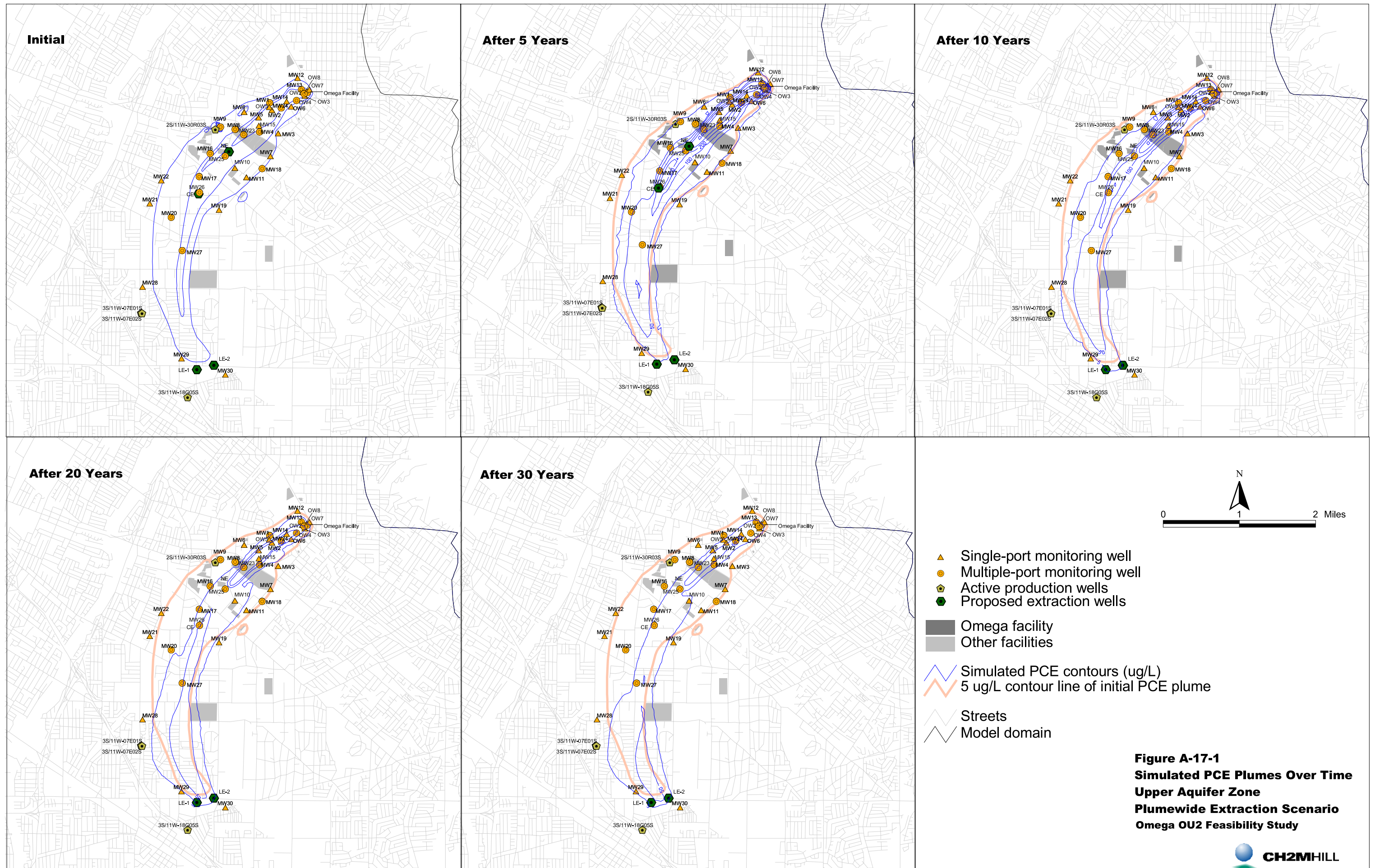




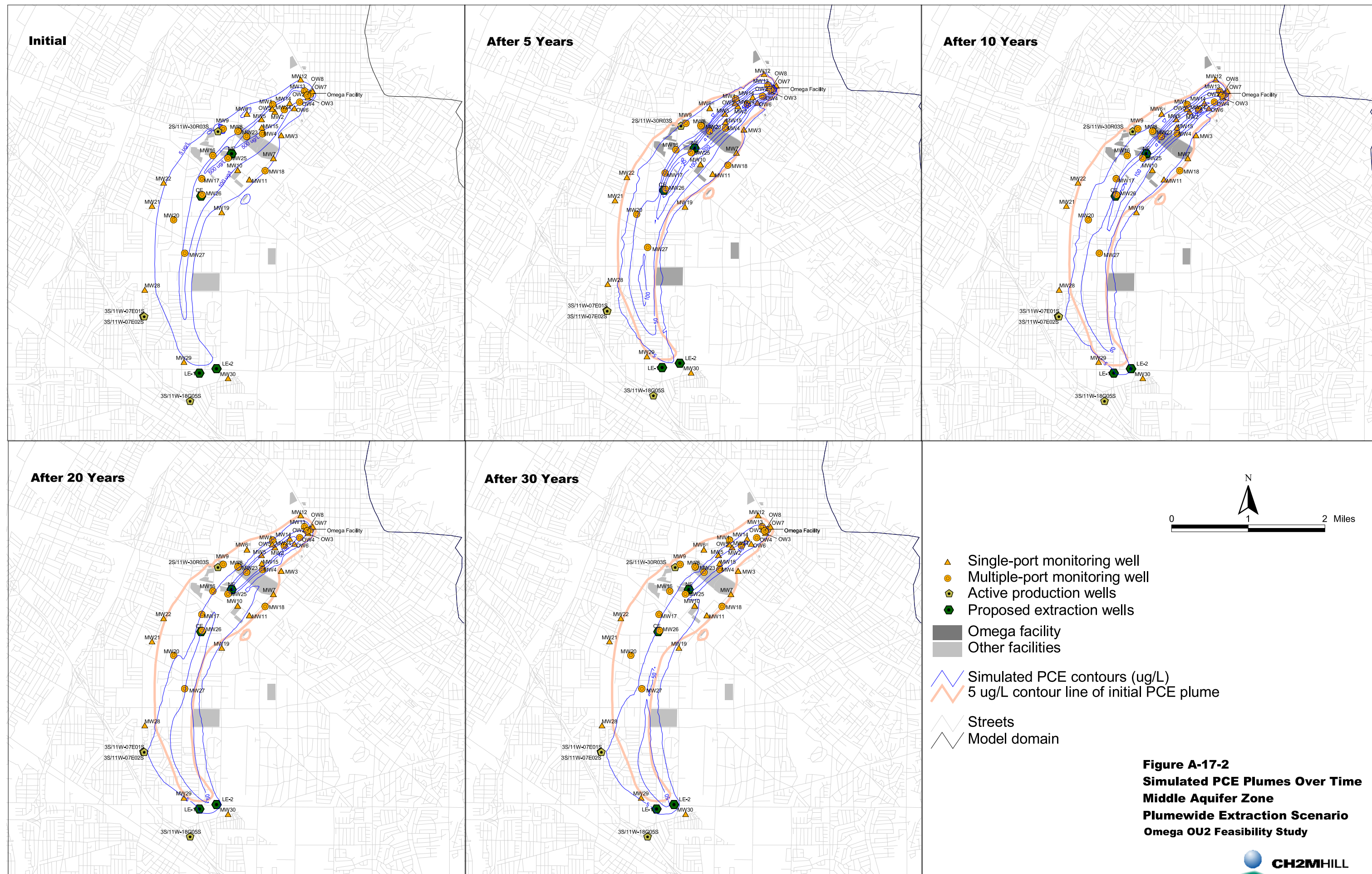




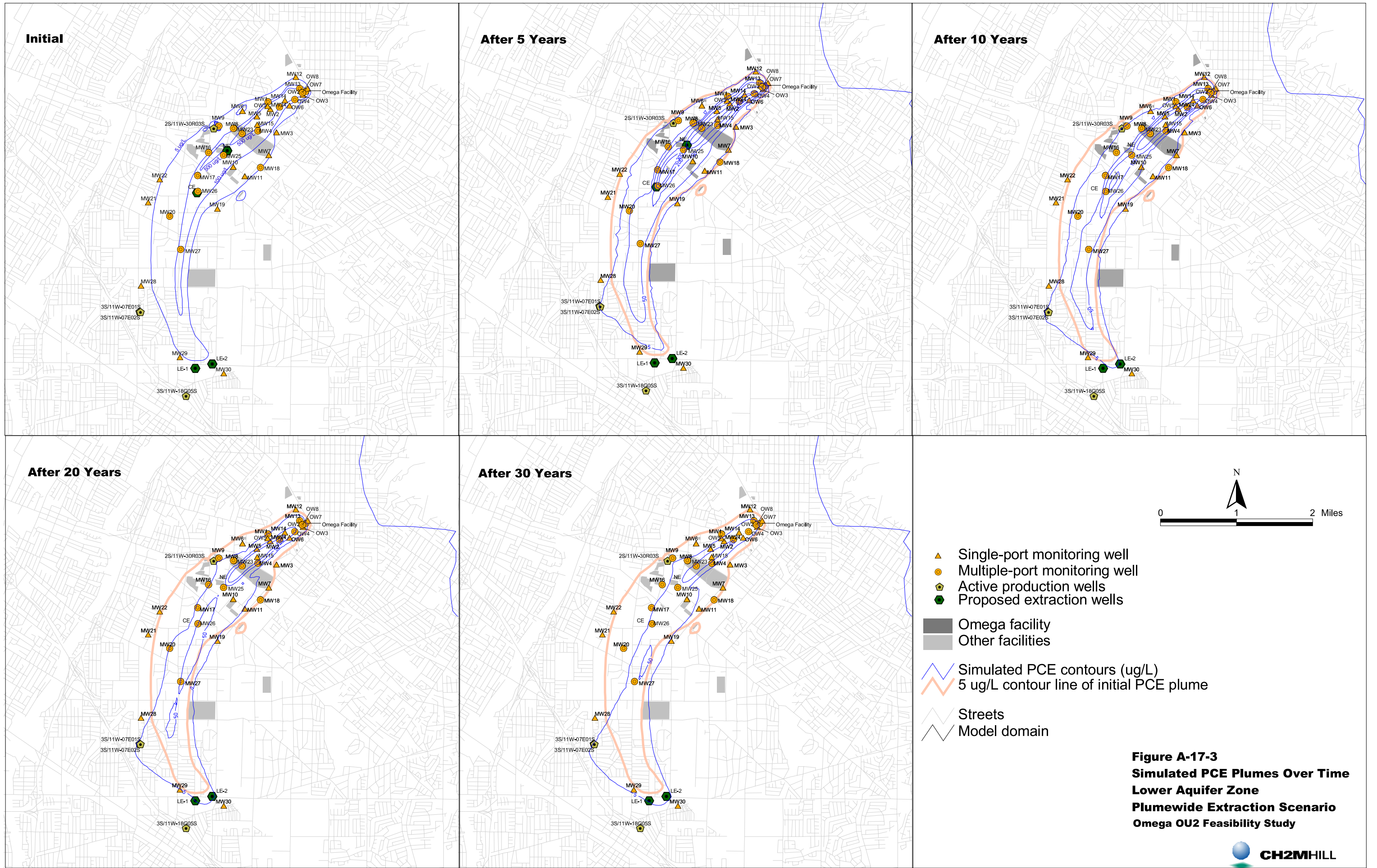














## **Appendix B**

### **Cost Estimates**

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## B.1 Introduction

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This appendix presents the cost estimates for the remedial alternatives and the methodology and design assumptions used to prepare this cost estimates. The cost estimates have been prepared with the consideration of industry standard cost-estimating references, costs of similar projects, and quotes from equipment and process vendors. The cost estimates are considered order-of-magnitude estimates with an expected accuracy of plus 50 percent and minus 30 percent.

The cost estimates presented herein have been prepared for guidance in project evaluation and implementation and are based on information available at the time this document is prepared. The final project cost and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, final design configuration, implementation schedule, continuation of personnel and engineering, and other variable factors. It is expected that the final project costs will vary from the opinions of cost presented herein. As such, the costs indicated do not necessarily represent the final cost of the project or individual alternative. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.



## B.2 Cost Estimate Methodology and Assumptions

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The following sections present a discussion of the assumptions and estimating methods used when estimating the costs for the remedial alternatives in the FS. Table B-1 presents a comparative summary of the costs for each of the alternatives. Tables B-2 through B-10 present cost breakdowns for each alternative for both capital costs and operations and maintenance (O&M) costs. Tables B-11 through B-13 present detailed cost information on extraction, monitoring, and injection wells. Table B-14 provides a summary of conveyance pipeline sizes and lengths for each alternative.

### B2.1 Capital Costs

Influent design concentrations and average concentrations for key contaminants of concern (COCs) for each of the remedial alternatives are listed in Tables 3-2 through 3-5.

The cost tables associated with each alternative include information on:

- Number and depth of extraction wells and monitoring wells. In the case of Alternative 4, information on the number of injection wells and their depth is provided as well.
- Conveyance pipeline routing for each alternative are shown in Figures 3-3, 3-5, 3-7, 3-9, and 3-11. Approximate pipeline sizes and lengths are summarized in Table B-14.
- Key equipment sizing or capacity information for the various treatment steps in the GWTP are discussed in Section 3 and in information provided on the respective cost tables.

Equipment cost information was obtained from a number of sources including Means Building Construction Cost Data, 2009; past equipment quotations that were prorated for size and/or escalated to today's costs, guidance documents, and in-house cost data. Pipeline costs are based on current estimates of materials and labor for trenching and backfill operations related to pipeline work. Pipeline lengths are based on the recommended locations of extraction wells, treatment plant, and treated or wastewater discharge sites.

The estimating methodology includes:

- Tabulation of Individual equipment system or item costs
- Application of standard factors to arrive at installation cost, which include site work; mechanical piping system; instrumentation and control; electrical; common facilities (e.g. parking lot, fencing, sanitary sewer connections, etc.); building (control room, office, restrooms, laboratory area); specialty metals; and provisions for a canopy cover over the membrane treatment process (nanofiltration or reverse osmosis systems).
- Application of standard factors to arrive at a total capital cost, which include:
  - Engineering-Design and technical support

- Contractors overhead, general conditions, mobilization/demobilization, temporary facilities
- Contractors profit
- Construction management
- Construction contingency

Land acquisition costs have not been included in the cost estimates. However, land acquisition costs should be similar for all alternatives and should not be a differentiator between them.

Potential pipeline franchise fees that may be imposed by local cities or agencies have not been included in the cost estimates. These costs could be significant. The need for pipeline franchise agreements should be addressed during the remedial design phase.

In addition, special one-time costs associated with Sanitation Districts of Los Angeles County (LACSD) sewer connection fees are also included for all alternatives.

## **B2.2 Operations and Maintenance Costs**

Annual O&M costs consist of expenditures required to ensure the effectiveness of a remedial action (RA) after construction and installation are completed. These costs include materials, utilities, labor, and services to operate and maintain the remedial action.

Influent average concentrations for key COCs used for estimating O&M costs for each of the remedial alternatives are listed in Tables 3-2 through 3-6. Average flow conditions used for estimating O&M costs are shown in the respective O&M cost tables for each alternative.

No charges for water rights are included in the O&M costs except for Alternative 3, the reclaimed water end use alternative. It is assumed that a Replenishment Assessment Exemption and Non-consumptive Water Use (NWU) Permit would be granted from the Water Replenishment District (WRD) of Southern California for the other alternatives. This exemption process requires partnering with a water rights holder in the Central Basin for the NWU and would likely be valid for 5 years. This case would be reviewed every 5 years to determine if the WRD would grant renewals for the RA exemption and the NWU Permit.

In addition, annual LACSD sewer discharge surcharge costs are included for all the alternatives for waste brine discharge from the treatment plants.

## **B2.3 Present Value Analysis**

The present worth of each annual or future cost is estimated on a discount rate of 7 percent and a 30-year period of operation. The period of operation does not reflect any specific finding regarding the duration of the alternatives. Total present worth is calculated as the sum of total capital costs and the present worth of the annual O&M costs. No equipment replacement costs are included in the cost.

**Table B-1**

## Alternatives Cost Summary

Feasibility Study, Omega Chemical Superfund Site OU2

Alternative	Alternative description		Capital Cost					O & M Cost		Total NPV <sup>(1)(4)</sup>
	Extraction Area	End Use	Conveyance & Wells	Treatment Plant	Treatment Plant (Future Cost)	PV of Future Capital Cost	Total Capital Cost <sup>(3)</sup>	Annual O&M Cost	NPV of O&M cost	
1	No Action	No Action	NA	NA	NA	NA	NA	NA	NA	NA
2	LE--Leading Edge Total <sup>(2)</sup>	Drinking water	\$ 6,245,300	\$ 22,667,000	\$ 881,000	\$ 319,300	\$29,231,600	\$ 1,965,200	\$ 24,386,200	<b>\$ 53,618,000</b>
3	Plume-wide Extraction	Reclaim Water	\$12,028,600	\$ 28,111,300	NA	NA	\$40,139,900	\$ 3,741,300	\$ 46,425,900	<b>\$ 86,566,000</b>
4	Plume-wide Extraction	Reinjection	\$12,609,700	\$ 28,745,800	NA	NA	\$41,355,500	\$ 2,563,900	\$ 31,815,500	<b>\$ 73,171,000</b>
5	Plume-wide Extraction	Spreading Basin	\$12,910,900	\$ 28,719,800	NA	NA	\$41,630,700	\$ 3,324,600	\$ 41,255,100	<b>\$ 82,886,000</b>
6	Plume-wide Extraction	Drinking water	\$12,420,600	\$ 26,001,800	NA	NA	\$38,422,400	\$ 2,481,397	\$ 30,791,800	<b>\$ 69,214,000</b>

<sup>(1)</sup> Total NPV is the Sum of NPV Capital Cost and NPV O&M Cost.<sup>(2)</sup> Alternative 2 may require an addition to the AOP treatment process to treat potentially higher 1,4-Dioxane concentrations at about the 15 year (midpoint of the assumed 30 year remedy).<sup>(3)</sup> Total capital cost for Alternative 2 includes the NPV of the future capital expenditure in the 15th year.<sup>(4)</sup> NPV Calculations based on 7% discount rate and 30-year project life<sup>(5)</sup> NA = Not applicable



Table B-2

Alternative 2 – Leading Edge Extraction With Drinking Water End Use (Initial Installation for Years 1 through 15)

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-1800 GPM; Avg. Flow-1200 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration, Disinfection

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
<b>CONVEYANCE &amp; WELL SYSTEM COSTS</b>							
<b>Water Pipelines (base)</b>							
<b>gpm</b>							
600	LE Extraction Segment 1	8	CML DI	900	\$ 55.80	\$ 50,220	
1200	LE Extraction Segment 2	10	CML DI	500	\$ 72.36	\$ 36,180	
1800	LE Extraction Segment 3	14	CML DI	2,600	\$ 95.88	\$ 249,288	
1350	Treated Potable Water to SFS Storage Tk	12	CML DI	9,200	\$ 81.65	\$ 751,180	
450	Brine Line to Indust Sewer Tie-In(@Florence)	8	CML DI	9,200	\$ 55.80	\$ 513,360	
	Bore & Jack Railroad Crossing	14", 14", 8"-3 pipes in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
<b>Extraction Wells</b>							
	New EW system at LE Area	3 @ 600 gpm ea X 200'		3	\$ 241,418	\$ 724,255	See Table B-15
	Investigation Derived Waste Mgmt			3	\$ 35,260	\$ 105,779	See Table B-15
<b>Monitoring Wells</b>							
	New Monitoring Wells	6 w/4 screened well intervals ea		6	\$ 72,800	\$ 436,800	See Table B-13
	Investigation Derived Waste Mgmt			6	\$ 35,260	\$ 211,557	See Table B-15
<b>Extraction Well Pumps and Well Head Ancillaries</b>							
	New EW systems	Pumps, Vaults, Valves, Gauges, Flow meters/totalizers, relief valves, power supply, etc.)		3	\$ 133,024	\$ 399,071	See Table B-15
<b>CONVEYANCE &amp; WELL SYSTEM SUBTOTAL A</b>						<b>\$ 3,609,716</b>	
	Engineering- Design and Technical Support			8%		\$ 288,777	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 541,457	
	Contractors Profit			8%		\$ 332,094	
	Construction Management			5%		\$ 224,163	
	Construction Contingency			25%		\$ 1,249,052	
<b>Conveyance and Extraction Well System Cost</b>						<b>\$ 6,245,300</b>	
<b>GROUNDWATER TREATMENT PLANT</b>							
<b>Untreated Water Tank</b>							
	Holding Tank	5,000 gallon	CS, Epoxy coated	1	\$ 32,077	\$ 32,077	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
<b>Treatment Plant Feed Pump</b>							
	Feed Pump	1800 gpm @ 200 ft H2O	Cl/SS trim	2	\$ 65,828	\$ 131,655	Johnson pump, 2003, prorated, escalated
	Flow indicating totalizer			1	\$ 4,000	\$ 4,000	
<b>Bag Filter System</b>							
	Bag Filters	1800 gpm	CS, Epoxy coated	2	\$ 20,403	\$ 40,806	Yardney quote, 2000, escalated
	Differential pressure switch	0 - 30 psig	Brass	1		included above	
<b>Advanced Oxidation Process (AOP)</b>							
	AOP System	1800 gpm; Infl 1,4-dioxane @ 3.6 ppb to <2 ppb design; 13.6 kw reqd, use 1 std 18.5 kw module					
	-- ASME Code vessels		CS	1	\$ 225,075	\$ 225,075	Prorated, Escalated Trojan Quote, 2004
	-- UV Light System (72 lamps)		Quartz/SS/Teflon		included		1720 gpm, 74 KW
	-- Piping inside AOP system		SS		included		
	-- Graphic Control Panel				included		

**Table B-2**

Alternative 2 – Leading Edge Extraction With Drinking Water End Use (Initial Installation for Years 1 through 15)

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-1800 GPM; Avg. Flow-1200 gpm

**Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration, Disinfection**

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
Peroxide Feed System	-- Holding Tank	10,000 gal	FRP	1	\$ 47,619	\$ 47,619	RS Means 2009, Prorated
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
<b>Sodium Metabisulfite Injection</b>	-- carboy			1		\$ -	Provided by supplier
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
<b>Biological LGAC Adsorber System</b>	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS each	CS, Epoxy coated	2	\$ 177,674	\$ 355,347	Vendor Quote (Calgon), 2003,escalated
	Differential Pressure Switch	0-30 psig	Brass	4	\$ 590	\$ 2,360	
	Flow indicating totalizer	8-inch		6	\$ 4,000	\$ 24,000	
<b>LGAC Adsorber System</b>	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS each	CS, Epoxy coated	4	\$ 177,674	\$ 710,694	Vendor Quote (Calgon), 2003,escalated
	Differential Pressure Switch	0-30 psig	Brass	8	\$ 590	\$ 4,720	
	Flow indicating totalizer	8-inch		10	\$ 4,000	\$ 40,000	
	BW and Rinse Recovery						RS Means 2009, Prorated
	-- Sloped bottom holding tank	30,000 gal	FRP	1	\$ 77,111	\$ 77,111	
	-- VGAC Drum			1	\$ 300	\$ 300	
	-- Diaphragm-type sludge pump			2	\$ 2,000	\$ 4,000	
	-- Polymer tank with mixer	50 gal	SS	1	\$ 3,845	\$ 3,845	
	-- Polymer feed pump	10 gph	316 SS	2	\$ 10,000	\$ 20,000	
	-- Tank level switch			1	\$ 1,500	\$ 1,500	
	-- Backwash Tank Decant Pump			1	\$ 3,000	\$ 3,000	
	-- Backwash Pump	950 gpm, 15 hp		1	\$ 8,825	\$ 8,825	
	-- Plate and frame filter press	5 cu. ft..	PVC	1	\$ 56,583	\$ 56,583	
<b>Biocide Injection</b>	-- carboy			1		\$ -	Provided by supplier
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
<b>Nanofiltration Feed Tank</b>	Tank @ 10 Min. ret time	18,000 gallon	CS, Epoxy coated	1	\$ 66,571	\$ 66,571	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
<b>Nanofiltration System (NF)</b>	NF System (75% Recovery)	1800 gpm	\$1.00/gpd	1	\$ 2,592,000	\$ 2,592,000	
	-- ASME Code vessels						
	-- 2-to-1 Tapered array						
	-- Booster pumps						
	-- CIP System						
	-- PLC Control system						
	-- pH Adjustment/Antiscalent Injection systems						
	-- Feed Pumps						
	-- Cartridge Filters						
	-- NF Reject Brine Pump( to sewer)	450 gpm @60 ft H2O		2	\$ 28,001	\$ 56,003	
	-- Flow indicating totalizer			1	\$ 4,000	\$ 4,000	

**Table B-2**

Alternative 2 – Leading Edge Extraction With Drinking Water End Use (Initial Installation for Years 1 through 15)

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-1800 GPM; Avg. Flow-1200 gpm

**Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration, Disinfection**

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
<b>Chlorination System</b>	Holding Tank, metering pumps, chlorine analyzer, mixer, etc.			Lump	\$ 85,000	\$ 85,000	
<b>Treated Water Tank</b>	Holding Tank	30,000 gallon	CS, Epoxy coated	1	\$ 89,071	\$ 89,071	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
<b>Treated Water Pump</b>	Treated Water Pump	1350 gpm @ 120 ft H2O	Cl/SS trim	2	\$ 50,579	\$ 101,158	Johnson pump, 2003, prorated, escalated
	Flow indicating totalizer			1	\$ 4,000	\$ 4,000	
<b>Installation</b>	<b>TREATMENT PLANT Equipment Material Only "B"</b>					<b>\$ 4,892,509</b>	
	<b>Labor For Equipment Installation</b>					<b>\$ 978,502</b>	
	<b>TREATMENT PLANT SUBTOTAL "B"</b>					<b>\$ 5,871,011</b>	
	Site work			5.0%	of Subtotal "B"	\$ 293,551	
	Mechanical Piping			15.0%	of Subtotal "B"	\$ 880,652	
	I&C			10.0%	of Subtotal "B"	\$ 587,101	
	Electrical			10.0%	of Subtotal "B"	\$ 587,101	
	Common Facilities			8.0%	of Subtotal "B"	\$ 469,681	
	Building--Office/Control Room/Lab/Restroom		Pre Fab Office	1	\$ 62,000	\$ 62,000	800 sf Pre Fab Office
	Metals			5.0%	of Subtotal "B"	\$ 293,551	
	NF Concrete Slab and Canopy Roof Structure			2500	\$ 42	\$ 105,000	
	<b>TREATMENT PLANT SUBTOTAL "C"</b>					<b>\$ 9,149,647</b>	
	Engineering- Design and Technical Support			8%		\$ 731,972	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 1,372,447	
	Contractors Profit			8%		\$ 841,768	
	Construction Management			5%		\$ 568,193	
	Construction Contingency			25%		<b>\$ 3,166,007</b>	
	DHS 97-005 Application Prep & Sampling Plans					\$ 100,000	Lump sum allowance
	LACSD Sewer Connection Fee			Lump		\$ 6,737,000	
<b>TOTAL TREATMENT PLANT COST</b>						<b>\$ 22,667,000</b>	
<b>GRAND TOTAL CONVEYANCE, WELL SYSTEM AND TREATMENT PLANT COST</b>						<b>\$ 28,912,300</b>	

**NOTES:**

1. All equipment cost adjustments for size based on the formula: Adjusted Cost = Orig. Cost \* (Adjusted Size/Orig. Size) EXP X  
 where "X" is 0.33 for pumps, 0.57 for Tanks, 0.62 for towers, and 0.6 for other process equipment.

2. Cost escalation adjustments from the following time periods were used, if needed, as appropriate.

**Escalation Factors**

2000-2009: 36.02%

2003-2009: 31.61%

2004-2009: 25.74%

2005-2009: 17.72

2008-2009: 4.21%



**Table B-3**

Alternative 2 – Leading Edge Extraction With Drinking Water End Use (Additional Treatment Equipment Needed for Yrs 16 through 30)

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-1800 GPM; Avg. Flow-1150 gpm

**Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration, Disinfection**

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
<b>CONVEYANCE &amp; WELL SYSTEM COSTS</b>							
No additional Equipment Needed for Years 16 through 30							
<b>Conveyance and Extraction Well System Cost</b>						<b>\$ -</b>	
<b>GROUNDWATER TREATMENT PLANT</b>							
<b>Advanced Oxidation Process (AOP)--Add Duplicate module in Series with Initial AOP installation</b>							
	AOP System	1800 gpm; Infl 1,4-dioxane @ 3.6 ppb to <2 ppb design; 29.3 kw reqd, add 2nd std 18.5 kw module to initial installation					
	-- ASME Code vessels		CS	1	\$ 225,075	\$ 225,075	Prorated, Escalated Trojan Quote, 2004 1720 gpm, 74 KW
	-- UV Light System (72 lamps)		Quartz/SS/Teflon		included		
	-- Piping inside AOP system		SS		included		
	-- Graphic Control Panel				included		
	Peroxide Feed System						
	-- Holding Tank	10,000 gal	FRP	1	\$ 47,619	\$ 47,619	RS Means 2009, Prorated
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	Provided with initial installation
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	NA	
Installation	<b>TREATMENT PLANT Equipment Material Only "B"</b>					<b>\$ 296,058</b>	
	<b>Labor For Equipment Installation</b>					<b>\$ 59,212</b>	
	<b>TREATMENT PLANT SUBTOTAL "B"</b>					<b>\$ 355,270</b>	
	Site work			5.0%	of Subtotal "B"	\$ 17,764	
	Mechanical Piping			15.0%	of Subtotal "B"	\$ 53,291	
	I&C			10.0%	of Subtotal "B"	\$ 35,527	
	Electrical			10.0%	of Subtotal "B"	\$ 35,527	
	Common Facilities			8.0%	of Subtotal "B"	NA	Provided with initial installation
	Building/Lab & Site Improvements		Butler building	Lump		NA	Provided with initial installation
	Metals			5.0%	of Subtotal "B"	\$ 17,764	
	<b>TREATMENT PLANT SUBTOTAL "C"</b>					<b>\$ 515,142</b>	
	Engineering- Design and Technical Support			8%		\$ 41,211	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 77,271	
	Contractors Profit			8%		\$ 47,393	
	Construction Management			5%		\$ 31,990	
	Construction Contingency			25%		\$ 167,949	
<b>TOTAL TREATMENT PLANT COST</b>						<b>\$ 881,000</b>	

**Table B-3**

Alternative 2 – Leading Edge Extraction With Drinking Water End Use (Additional Treatment Equipment Needed for Yrs 16 through 30)

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-1800 GPM; Avg. Flow-1150 gpm

**Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration, Disinfection**

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
GRAND TOTAL CONVEYANCE, WELL SYSTEM AND TREATMENT PLANT COST						\$ 881,000	

## NOTES:

1. All equipment cost adjustments for size based on the formula: Adjusted Cost = Orig. Cost \* (Adjusted Size/Orig. Size) EXP X  
where "X" is 0.33 for pumps, 0.57 for Tanks, 0.62 for towers, and 0.6 for other process equipment.
2. Cost escalation adjustments from the following time periods were used, if needed, as appropriate.

**Escalation Factors**

2000-2009: 36.02%  
2003-2009: 31.61%  
2004-2009: 25.74%  
2005-2009: 17.72  
2008-2009: 4.21%

Table B-4

Alternative 2 – Leading Edge Extraction With Drinking Water End Use (Initial Installation for Years 1 through 15)

Operations and Maintenance Cost Estimate Summary

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-1800 GPM; Avg. Flow-1200 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration, Disinfection

O&M Category	Equip. Name	Equip. Description	O&M Requirement per Unit	Number of Units	Total Requirements	Units	Unit Cost	Cost
Electrical Power	LE Well Pumps to Treatment Plant	400 gpm @ 250'	207,006	3	621,019	kW-hr		
	CE Wells Pumps to Treatment Plant	NA						
	LE Wells Pumps to Treatment Plant	NA						
	Treatment Plant Feed Pump	1200 gpm @ 200'	496,815	1	496,815	kW-hr		
	Advanced Oxidation Process (kw)	9.1	83,912	1	83,912	kW-hr		
	NF System(1200 gpm avg flow)	1200 gpm @350'	869,427	1	869,427	kW-hr		
	Reject Brine Pump	300 gpm @ 70'	43,471	1	43,471	kW-hr		
	Treated Water Pump to SFS PW Tank	900 gpm @ 120'	223,567	1	223,567	kW-hr		
	Backwash Decant Pump	200 gpm @ 30', 10% time	1,242	1	1,242	kW-hr		
	LGAC Backwash Pumps	1100 gpm @ 75', 1%	1,708	2	3,416	kW-hr		
	Misc. Controls/Lights (allowance)	1,500 W	16,466	1	16,466	kW-hr		
	<b>Total</b>				2,359,335	kW-hr	\$ 0.12	\$ 283,120
Carbon Make-up	LGAC	711 lb/day	259,515	1	259,515	lb C	\$ 1.00	\$ 259,515
Chemicals/Materials	Ion Exchange Resin	NA		1	0		\$ 145.00	\$ -
	Hydrogen Peroxide (AOP Process)	25 ppm	131347	1	131347	lb	\$ 1.00	\$ 131,347
	Sodium metabisulfite	6 ppm	31523	1	31523	lb	\$ 1.00	\$ 31,523
	NF or RO Operations (CIP, consumables, etc.)	\$0.26/1000 gal	\$ 163,987	1	163987	yr		\$ 163,987
	H2SO4 (for pH Adjustment)	NA			-	lb	\$ 0.15	\$ -
	NaOH (for pH Adjustment)	NA			-	lb dry	\$ 0.11	\$ -
	Sodium Hypochlorite	2 ppm	10,520	1	10,520	lb	\$ 0.50	\$ 5,260
	Filter Bags	Weekly bag replacement	104	1	104	ea	\$ 70.00	\$ 7,280
	NF biocide (incl with NF consumables)							
	Polymer (for backwash system/sludge filter)	Negligible						
	UV Lamp Replacement		\$ 6,500	1	1	\$	6,500	\$ 6,500
Residuals Disposal	LGAC	Included above						
	Backwash Sludge Cake (allowance)	1% of carbon as 30% sludge	4.3	1	4.3	tons	\$ 500.00	\$ 2,163
	Ion Exchange Resin	Included above						
Analytical	Treatment Plant	Effluent	Weekly	52		ea	\$ 300.00	\$ 15,600
	Extraction Wells	3 wells	Quarterly	12		ea	\$ 300.00	\$ 3,600
	Monitoring Wells	6 MWs @ 4 ports ea	Semiannual/Annual	48		ea	\$ 300.00	\$ 14,400
	Water Samples - Additional Annual Tests-allowance			6		ea.	\$ 1,000.00	\$ 6,000
	DHS 9-005 sampling	Lump sum allowance						\$ 40,000
Labor	Well Operating	1 Hr/day		365		hrs	\$ 45.00	\$ 16,425
	Well Maintenance	1 Hr/day		365		hrs	\$ 45.00	\$ 16,425
	Operating--GWTP	8 Hrs /day		2920		hrs	\$ 45.00	\$ 131,400
	Maintenance-GWTP	6 Hrs/day		2190		hrs	\$ 45.00	\$ 98,550
	Supervisory	3 Hrs/day		1095		hrs	\$ 50.00	\$ 54,750
	Clerical	3 Hrs/day		1095		hrs	\$ 20.00	\$ 21,900

**Table B-4**

Alternative 2 – Leading Edge Extraction With Drinking Water End Use (Initial Installation for Years 1 through 15)

Operations and Maintenance Cost Estimate Summary

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-1800 GPM; Avg. Flow-1200 gpm

**Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration, Disinfection**

<u>O&amp;M Category</u>	<u>Equip. Name</u>	<u>Equip. Description</u>	<u>O&amp;M Requirement per Unit</u>	<u>Number of Units</u>	<u>Total Requirements</u>	<u>Units</u>	<u>Unit Cost</u>	<u>Cost</u>
<b>Subcontracts</b>								
	Monitoring Wells Sampling (Subcontract)			1		lot	\$ 90,000.00	\$ 90,000
	Regulatory Monitoring reports allowance (RWQCB, EPA, Air Emissions Inventory)			1		lot	\$ 25,000.00	\$ 25,000
<b>Parts</b>								
	2% of TP Capital				2%		\$ 9,149,647	\$ 182,993
								\$ 1,640,000
<b>Contingency on Materials/Services</b>					10%			<u>\$ 164,000</u>
<b>LACSD Annual Sewer Surcharge</b>			Annual	1			\$ 161,198	\$ 161,198
<b>GRAND TOTAL</b>								<b>\$ 1,965,198</b>

Table B-5

Alternative 3 – Plume-Wide Extraction With Reclaimed Water End Use

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
<b>CONVEYANCE &amp; WELL SYSTEM COSTS</b>							
<b>Water Pipelines (base)</b>							
<b>gpm</b>							
350	LE Extraction Segment 1	6	CML DI	900	\$ 50.00	\$ 45,000	
700	LE Extraction Segment 2	8	CML DI	500	\$ 55.80	\$ 27,900	
1,050	LE Extraction Segment 3	12	CML DI	14,700	\$ 81.65	\$ 1,200,255	
500	CE Extracted Water Pipeline	8	CML DI	4,500	\$ 55.80	\$ 251,100	
500	NE Extracted Water Pipeline	8	CML DI	6,100	\$ 55.80	\$ 340,380	
250	Brine Line to Indust Sewer Tie-In(@Florence)	6	CML DI	6,000	\$ 50.00	\$ 300,000	
1,750	Reclaim Water to Trunk Line Tie-In @ Florence	14	CML DI	6,000	\$ 95.88	\$ 575,280	
	Bore & Jack Railroad Crossing	8" pipeline in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
	Bore & Jack Railroad Crossing	8" pipeline in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
<b>Extraction Wells</b>							
	New EW system at LE	3 @ 350 gpm ea X 200'		3	\$ 241,418	\$ 724,255	See Table B-15
	New EW system at CE	2 @ 250 gpm ea X 200'		2	\$ 241,418	\$ 482,836	See Table B-15
	New EW system at NE	2 @ 250 gpm ea X 200'		2	\$ 241,418	\$ 482,836	See Table B-15
	Investigation Derived Waste Mgmt			7	\$ 35,260	\$ 246,817	See Table B-15
<b>Monitoring Wells</b>							
	New Monitoring Wells	10 w/4 screened well intervals ea		10	\$ 72,800	\$ 728,000	See Table B-13
	Investigation Derived Waste Mgmt			10	\$ 35,260	\$ 352,595	See Table B-15
<b>Extraction Well Pumps and Well Head Ancillaries</b>							
	New EW systems	Pumps, Vaults, Valves, Gauges, Flow meters/totalizers, relief valves, power supply, etc.)		7	\$ 133,024	\$ 931,165	See Table B-11
<b>CONVEYANCE &amp; WELL SYSTEM SUBTOTAL A</b>						<b>\$ 6,952,474</b>	
	Engineering- Design and Technical Support			8%		\$ 556,198	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 1,042,871	
	Contractors Profit			8%		\$ 639,628	
	Construction Management			5%		\$ 431,749	
	Construction Contingency			25%		\$ 2,405,730	
<b>Conveyance and Extraction Well System Cost</b>						<b>\$ 12,028,600</b>	
<b>GROUNDWATER TREATMENT PLANT</b>							
<b>Untreated Water Tank</b>							
	Holding Tank	6,000 gallon	CS, Epoxy coated	1	\$ 35,590	\$ 35,590	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
<b>Treatment Plant Feed Pump</b>							
	Feed Pump	2000 gpm @ 250 ft H2O	CI/SS trim	2	\$ 73,365	\$ 146,730	Johnson pump, 2003, prorated, escalated
	Flow indicating totalizer	8-inch		1	\$ 4,000	\$ 4,000	
<b>Bag Filter System</b>							
	Bag Filters	2000 gpm	CS, Epoxy coated	2	\$ 20,403	\$ 40,806	Yardney quote, 2000, escalated
	Differential pressure switch	0 - 30 psig	Brass	1		included above	

Table B-5

Alternative 3 – Plume-Wide Extraction With Reclaimed Water End Use

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
Inline Mixer-Acid Injection Injection							
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	CH2M estimate
Sulfuric Acid System							
	-- Storage Tank	10,000 gal	CS	1	\$ 47,619	\$ 47,619	RS Means 2009, Prorated
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
Ion Exchange System							
	Resin adsorber columns (2 pair)	Lead/lag config; 12' Dia ea.; 350 cu.ft resin ea vessel		4	\$ 342,639	\$ 1,370,558	US Filter 2004,prorated,escalated
	Initial Resin Charge	8 vessels @ 350 cu. ft.. ea	Cu. FT of resin	2800	\$ 418.71	\$ 1,172,400	
Inline Mixer- Caustic Injection							
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	CH2M estimate
Caustic System							
	-- Storage Tank	15,000 gal	CS	1	\$ 60,000	\$ 60,000	RS Means 2009, Prorated
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
Advanced Oxidation Process (AOP)--Trojan System							
	AOP System	2000 gpm; Infl 1,4-dioxane @ 13.2 ppb to <2 ppb design; 48.5 kw reqd, use 3 std 18.5 kw modules					Prorated, Escalated Trojan Quote, 2004
	-- ASME Code vessels		CS	1	\$ 542,254	\$ 542,254	
	-- UV Light System (72 lamps)		Quartz/SS/Teflon		included		
	-- Piping inside AOP system		SS		included		
	-- Graphic Control Panel				included		
	Peroxide Feed System						RS Means 2009, Prorated
	-- Holding Tank	10,000 gal	FRP	1	\$ 47,619	\$ 47,619	
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
Sodium Metabisulfite Injection							
	-- carboy			1		\$ -	Provided by supplier
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
Biological LGAC Adsorber System							
	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS eac	CS, Epoxy coated	2.5	\$ 177,674	\$ 444,184	Vendor Quote (Calgon), 2003,escalated
	Differential Pressure Switch	0-30 psig	Brass	5	\$ 590	\$ 2,950	
	Flow indicating totalizer	8-inch		7	\$ 4,000	\$ 28,000	
LGAC Adsorber System							
	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS eac	CS, Epoxy coated	5	\$ 177,674	\$ 888,368	Vendor Quote (Calgon), 2003,escalated
	Differential Pressure Switch	0-30 psig	Brass	10	\$ 590	\$ 5,900	
	Flow indicating totalizer	8-inch		12	\$ 4,000	\$ 48,000	

Table B-5

Alternative 3 – Plume-Wide Extraction With Reclaimed Water End Use

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
	BW and Rinse Recovery						
	-- Sloped bottom holding tank	30,000 gal	FRP	1	\$ 77,111	\$ 77,111	RS Means 2009, Prorated
	-- VGAC Drum			1	\$ 300	\$ 300	
	-- Diaphragm-type sludge pump			2	\$ 2,000	\$ 4,000	
	-- Polymer tank with mixer	50 gal	SS	1	\$ 3,845	\$ 3,845	Means 2009 Vendor Quote (US Filter), 2004, prorated, escalated
	-- Polymer feed pump	10 gph	316 SS	2	\$ 10,000	\$ 20,000	
	-- Tank level switch			1	\$ 1,500	\$ 1,500	
	-- Backwash Tank Decant Pump			1	\$ 3,000	\$ 3,000	
	-- Backwash Pump	950 gpm, 15 hp		1	\$ 8,825	\$ 8,825	
	-- Plate and frame filter press	5 cu. ft..	PVC	1	\$ 56,583	\$ 56,583	
Biocide Injection	-- carboy			1		\$ -	Provided by supplier
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
RO Feed Tank							
	Tank @ 10 Min. ret time Level Switch	20,000 gallon	CS, Epoxy coated	1 1	\$ 70,691 \$ 365	\$ 70,691 \$ 365	RS Means 2009, Prorated
Reverse Osmosis System (RO)							
	RO System (75% Recovery)	1000 gpm	\$1.40/gpd	1	\$ 2,016,000	\$ 2,016,000	
	-- ASME Code vessels						
	-- 2-to-1 Tapered array						
	-- Booster pumps						
	-- CIP System						
	-- PLC Control system						
	-- pH Adjustment/Antiscalent Injection systems						
	-- Feed Pumps						
	-- Cartridge Filters						
	-- RO Reject Brine Pump( to sewer)	250 gpm @ 220 ft H2O		2	\$ 35,412	\$ 70,824	Johnson pump, 2003, prorated, escalated
	-- Flow indicating totalizer			1	\$ 4,000	\$ 4,000	
Treated Water Tank							
	Holding Tank	30,000 gallon	CS, Epoxy coated	1	\$ 89,071	\$ 89,071	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
Treated Water Pump							
	Treated Water Pump	1820 gpm @ 200 ft H2O	CI/SS trim	2	\$ 66,068	\$ 132,136	Johnson pump, 2003, prorated, escalated
	Flow indicating totalizer			1	\$ 4,000	\$ 4,000	
Installation	TREATMENT PLANT Equipment Material Only "B"					\$ 7,614,782	
	Labor For Equipment Installation					\$ 1,522,956	
	TREATMENT PLANT SUBTOTAL "B"					\$ 9,137,739	
	Site work			5.0%	of Subtotal "B"	\$ 456,887	
	Mechanical Piping			15.0%	of Subtotal "B"	\$ 1,370,661	

**Table B-5**

Alternative 3 – Plume-Wide Extraction With Reclaimed Water End Use

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

**Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis**

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
	I&C			10.0%	of Subtotal "B"	\$ 913,774	
	Electrical			10.0%	of Subtotal "B"	\$ 913,774	
	Common Facilities			8.0%	of Subtotal "B"	\$ 731,019	
	Building--Office/Control Room/Lab/Restroom		Pre Fab Office	1	\$ 62,000	\$ 62,000	800 sf Pre Fab Office
	Metals			5.0%	of Subtotal "B"	\$ 456,887	
	RO Concrete Slab and Roof Structure			1000	\$ 42	\$ 42,000	
	<b>TREATMENT PLANT SUBTOTAL "C"</b>					<b>\$ 14,084,741</b>	
	Engineering- Design and Technical Support			8%		\$ 1,126,779	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 2,112,711	
	Contractors Profit			8%		\$ 1,295,796	
	Construction Management			5%		\$ 874,662	
	Construction Contingency			25%		<b>\$ 4,873,672</b>	
	LACSD Sewer Connection Fee			Lump		\$ 3,742,902	
	<b>TOTAL TREATMENT PLANT COST</b>					<b>\$ 28,111,300</b>	
	<b>GRAND TOTAL CONVEYANCE, WELL SYSTEM AND TREATMENT PLANT COST</b>					<b>\$ 40,139,900</b>	

NOTES:

- All equipment cost adjustments for size based on the formula: Adjusted Cost = Orig. Cost \* (Adjusted Size/Orig. Size) EXP X  
where "X" is 0.33 for pumps, 0.57 for Tanks, 0.62 for towers, and 0.6 for other process equipment.
- Cost escalation adjustments from the following time periods were used, if needed, as appropriate.

**Escalation Factors**

2000-2009: 36.02%

2003-2009: 31.61%

2004-2009: 25.74%

2005-2009: 17.72

2008-2009: 4.21%

Table B-6

Alternative 3 – Plume-Wide Extraction With Reclaimed Water End Use

Operations and Maintenance Cost Estimate Summary

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis

O&M Category	Equip. Name	Equip. Description	O&M Requirement per Unit	Number of Units	Total Requirements	Units	Unit Cost	Cost
Electrical Power	LE Well Pumps to Treatment Plant	235 gpm @ 300'	145,940	3	437,819	kW-hr		
	CE Wells Pumps to Treatment Plant	170 gpm @ 250'	87,978	2	175,955	kW-hr		
	LE Wells Pumps to Treatment Plant	170 gpm @ 270'	95,016	2	190,032	kW-hr		
	Treatment Plant Feed Pump	1300 gpm @ 270'	726,592	1	726,592	kW-hr		
	Advanced Oxidation Process (kw)	31.5	290,463	1	290,463	kW-hr		
	RO System(650 gpm avg flow)	650 gpm @ 700'	941,879	1	941,879	kW-hr		
	Reject Brine Pump	160 gpm @ 63'	20,866	1	20,866	kW-hr		
	Treated Water Pump to Reclaim Trunk line	1140 gpm @ 194'	457,815	1	457,815	kW-hr		
	Backwash Decant Pump	200 gpm @ 30', 10% time	1,242	1	1,242	kW-hr		
	LGAC Backwash Pumps	1100 gpm @ 75', 1%	1,708	2	3,416	kW-hr		
	Misc. Controls/Lights (allowance)	1,500 W	16,466	1	16,466	kW-hr		
	<b>Total</b>				3,262,546	kW-hr	\$ 0.12	\$ 391,506
Carbon Make-up	LGAC	940 lb/day	343,100	1	343,100	lb C	\$ 1.00	\$ 343,100
Chemicals/Materials	Ion Exchange Resin	950 cu. ft./yr	950	1	950	cu. ft.	\$ 595.51	\$ 565,735
	Hydrogen Peroxide (AOP Process)	25 ppm	142,293	1	142,293	lb	\$ 1.00	\$ 142,293
	Sodium metabisulfite	6 ppm	34,150	1	34,150	lb	\$ 1.00	\$ 34,150
	NF or RO Operations (CIP, consumables, etc.)	\$0.26/1000 gal	\$ 177,653	1	177,653	yr		\$ 177,653
	H2SO4 (for pH Adjustment)	215 ppm dosage	1034361	1	1,034,361	lb	\$ 0.15	\$ 155,154
	NaOH (for pH Adjustment)	175 ppm dosage	1034361	1	1,034,361	lb dry	\$ 0.11	\$ 113,780
	Sodium Hypochlorite	NA	-	1	-	lb	\$ 0.50	\$ -
	Filter Bags	Weekly bag replacement	104	1	104	ea	\$ 70.00	\$ 7,280
	RO biocide (incl with RO consumables)							
	Polymer (for backwash system/sludge filter)	Negligible						
	UV Lamp Replacement		\$ 22,400	1	1	\$	22,400	\$ 22,400
Residuals Disposal	LGAC	Included above						
	Backwash Sludge Cake (allowance)	1% of carbon as 30% sludge	5.7	1	5.7	tons	\$ 500.00	\$ 2,859
	Ion Exchange Resin	Included above						
Analytical	Treatment Plant	Effluent	Weekly	52		ea	\$ 300.00	\$ 15,600
	Extraction Wells	7 wells	Quarterly	28		ea	\$ 300.00	\$ 8,400
	Monitoring Wells	10 MWs @ 4 ports ea	Semiannual/Annual	80		ea	\$ 300.00	\$ 24,000
	Water Samples - Additional Annual Tests-allowance			6		ea.	\$ 1,000.00	\$ 6,000
Labor	Well Operating	2 Hr/day		730		hrs	\$ 45.00	\$ 32,850
	Well Maintenance	2 Hr/day		730		hrs	\$ 45.00	\$ 32,850
	Operating-GWTP	12 Hrs /day		4380		hrs	\$ 45.00	\$ 197,100
	Maintenance-GWTP	8 Hrs/day		2920		hrs	\$ 45.00	\$ 131,400
	Supervisory	4 Hrs/day		1460		hrs	\$ 50.00	\$ 73,000
	Clerical	3 Hrs/day		1095		hrs	\$ 20.00	\$ 21,900

**Table B-6**

Alternative 3 – Plume-Wide Extraction With Reclaimed Water End Use

Operations and Maintenance Cost Estimate Summary

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

**Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis**

<b>O&amp;M Category</b>	<b>Equip. Name</b>	<b>Equip. Description</b>	<b>O&amp;M Requirement per Unit</b>	<b>Number of Units</b>	<b>Total Requirements</b>	<b>Units</b>	<b>Unit Cost</b>	<b>Cost</b>
<b>Subcontracts</b>								
	Monitoring Wells Sampling (Subcontract)			1		lot	\$ 90,000.00	\$ 90,000
	Regulatory Monitoring reports allowance (RWQCB, EPA, Air Emissions Inventory)			1		lot	\$ 25,000.00	\$ 25,000
<b>Parts</b>								
	2% of TP Capital				2%		\$ 14,084,741	\$ 281,695
								\$ 2,928,000
<b>Contingency on Materials/Services</b>					10%			\$ 292,800
<b>WRD Replenishment fees</b>		\$205/AF		2102.4	2102.4	AF	\$ 205	\$ 430,992
<b>LACSD Annual Sewer Surcharge</b>			Annual	1			\$ 89,530	\$ 89,530
<b>GRAND TOTAL</b>								<b>\$ 3,741,322</b>

Table B-7

Alternative 4 – Plume-Wide Extraction With Reinjection

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Reverse Osmosis

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
<b>CONVEYANCE &amp; WELL SYSTEM COSTS</b>							
<b>Water Pipelines (base)</b>							
<b>gpm</b>							
350	LE Extraction Segment 1	6	CML DI	900	\$ 50.00	\$ 45,000	
700	LE Extraction Segment 2	8	CML DI	500	\$ 55.80	\$ 27,900	
1,050	LE Extraction Segment 3	12	CML DI	14700	\$ 81.65	\$ 1,200,255	
500	CE Extracted Water Pipeline	8	CML DI	4500	\$ 55.80	\$ 251,100	
500	NE Extracted Water Pipeline	8	CML DI	6100	\$ 55.80	\$ 340,380	
500	Brine Line to Indust Sewer Tie-In(@Florence)	8	CML DI	6000	\$ 55.80	\$ 334,800	
1,500	Treated Water to Injection Wells	14	CML DI	500	\$ 95.88	\$ 47,940	
	Bore & Jack Railroad Crossing	8" pipeline in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
	Bore & Jack Railroad Crossing	8" pipeline in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
<b>Extraction</b>							
	New EW system at LE	3 @ 350 gpm ea X 200'		3	\$ 241,418	\$ 724,255	See Table B-15
	New EW system at CE	2 @ 250 gpm ea X 200'		2	\$ 241,418	\$ 482,836	See Table B-15
	New EW system at NE	2 @ 250 gpm ea X 200'		2	\$ 241,418	\$ 482,836	See Table B-15
	Investigation Derived Waste Mgmt			7	\$ 35,260	\$ 246,817	See Table B-15
<b>New Monitoring Wells</b>							
	New Monitoring Wells	10 w/4 screened well intervals ea		10	\$ 72,800	\$ 728,000	See Table B-13
	Investigation Derived Waste Mgmt			10	\$ 35,260	\$ 352,595	See Table B-15
<b>Injection Well</b>							
	Injection Wells	500'		2	\$ 361,351	\$ 722,703	See Table B-16
	Investigation Derived Waste Mgmt			2	\$ 52,844	\$ 105,688	See Table B-15
<b>Extraction Well Pumps and Well Head Ancillaries</b>							
	New EW systems	Pumps, Vaults, Valves, Gauges, Flow meters/totalizers, relief valves, power supply, etc.)		7	\$ 133,024	\$ 931,165	See Table B-15
<b>CONVEYANCE &amp; WELL SYSTEM SUBTOTAL A</b>						<b>\$ 7,288,325</b>	
	Engineering- Design and Technical Support			8%		\$ 583,066	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 1,093,249	
	Contractors Profit			8%		\$ 670,526	
	Construction Management			5%		\$ 452,605	
	Construction Contingency			25%		\$ 2,521,942	
<b>Conveyance and Extraction Well System Cost</b>						<b>\$ 12,609,700</b>	
<b>GROUNDWATER TREATMENT PLANT</b>							
<b>Untreated Water Tank</b>							
	Holding Tank	6,000 gallon	CS, Epoxy coated	1	\$ 35,590	\$ 35,590	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
<b>Treatment Plant Feed Pump</b>							
	Feed Pump	2000 gpm @ 250 ft H2O	Cl/SS trim	2	\$ 73,365	\$ 146,730	Johnson pump, 2003, prorated, escalated
	Flow indicating totalizer	8-inch		1	\$ 4,000	\$ 4,000	
<b>Bag Filter System</b>							
	Bag Filters	2000 gpm	CS, Epoxy coated	2	\$ 20,403	\$ 40,806	Yardney quote, 2000, escalated
	Differential pressure switch	0 - 30 psig	Brass	1		included above	
<b>Advanced Oxidation Process (AOP)--Trojan System</b>							
	AOP System	2000 gpm; Infl 1.4-dioxane @ 13.2 ppb to <0.05 ppb design; 143.2 kw reqd, use 8 std 18.5 kw modules					
	-- ASME Code vessels		CS	1	\$ 1,446,010	\$ 1,446,010	Prorated, Escalated Trojan Quote, 2004
	-- UV Light System (72 lamps)		Quartz/SS/Teflon		included		
	-- Piping inside AOP system		SS		included		
	-- Graphic Control Panel				included		
	Peroxide Feed System						
	-- Holding Tank	10,000 gal	FRP	1	\$ 47,619	\$ 47,619	RS Means 2009, Prorated
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	

Table B-7

Alternative 4 – Plume-Wide Extraction With Reinjection

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Reverse Osmosis

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source	
Sodium Metabisulfite Injection								
	-- carboy			1		\$ -	Provided by supplier	
	-- Tank level switch			1	\$ 365	\$ 365		
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000		
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000		
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000		
Biological LGAC Adsorber System								
	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS each	CS, Epoxy coated	2.5	\$ 177,674	\$ 444,184	Vendor Quote (Calgon), 2003,escalated	
	Differential Pressure Switch	0-30 psig	Brass	5	\$ 590	\$ 2,950		
	Flow indicating totalizer	8-inch		7	\$ 4,000	\$ 28,000		
LGAC Adsorber System								
	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS each	CS, Epoxy coated	5	\$ 177,674	\$ 888,368	Vendor Quote (Calgon), 2003,escalated	
	Differential Pressure Switch	0-30 psig	Brass	10	\$ 590	\$ 5,900		
	Flow indicating totalizer	8-inch		12	\$ 4,000	\$ 48,000		
	BW and Rinse Recovery						RS Means 2009, Prorated	
	-- Sloped bottom holding tank	30,000 gal	FRP	1	\$ 77,111	\$ 77,111		
	-- VGAC Drum			1	\$ 300	\$ 300		
	-- Diaphragm-type sludge pump			2	\$ 2,000	\$ 4,000		
	-- Polymer tank with mixer	50 gal	SS	1	\$ 3,845	\$ 3,845		
	-- Polymer feed pump	10 gph	316 SS	2	\$ 10,000	\$ 20,000		
	-- Tank level switch			1	\$ 1,500	\$ 1,500		
	-- Backwash Tank Decant Pump			1	\$ 3,000	\$ 3,000		
	-- Backwash Pump	950 gpm, 15 hp		1	\$ 8,825	\$ 8,825		
	-- Plate and frame filter press	5 cu. ft..	PVC	1	\$ 56,583	\$ 56,583		
								Means 2009
								Vendor Quote (US Filter), 2004, prorated, escalated
Biocide Injection								
	-- carboy			1		\$ -	Provided by supplier	
	-- Tank level switch			1	\$ 365	\$ 365		
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000		
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000		
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000		
RO Feed Tank								
	Tank @ 10 Min. ret time	20,000 gallon	CS, Epoxy coated	1	\$ 70,691	\$ 70,691	RS Means 2009, Prorated	
	Level Switch			1	\$ 365	\$ 365		
Reverse Osmosis System (RO)								
	RO System (75% Recovery)	2000 gpm	\$1.00/gpd	1	\$ 2,880,000	\$ 2,880,000	Johnson pump, 2003, prorated, escalated	
	-- ASME Code vessels							
	-- 2-to-1 Tapered array							
	-- Booster pumps							
	-- CIP System							
	-- PLC Control system							
	-- pH Adjustment/Antiscalent Injection systems							
	-- Feed Pumps							
	-- Cartridge Filters							
	-- RO Reject Brine Pump( to sewer)	500 gpm @60 ft H2O		2	\$ 28,992	\$ 57,984		
	-- Flow indicating totalizer			1	\$ 4,000	\$ 4,000		
Inj Well Cleaning & Water Conditioning Chemicals Injection								
	-- carboy			2		\$ -	Provided by supplier	
	-- Tank level switch			2	\$ 365	\$ 730		
	-- Metering Pumps	0.5 gpm	Acid Spec	4	\$ 10,000	\$ 40,000		
	-- Pulsation dampener		Acid Spec	2	\$ 3,000	\$ 6,000		
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000		
Treated Water Tank								
	Holding Tank	30,000 gallon	CS, Epoxy coated	1	\$ 89,071	\$ 89,071	RS Means 2009, Prorated	
	Level Switch			1	\$ 365	\$ 365		
Treated Water Pump								
	Treated Water Pump	1500 gpm @ 25 ft H2O	Cl/SS trim	2	\$ 31,207	\$ 62,415	Johnson pump, 2003, prorated, escalated	
	Flow indicating totalizer			1	\$ 4,000	\$ 4,000		
Inj Well Cartridge filters								
	Cartridge Filters	2000 gpm	CS, Epoxy coated	2	\$ 20,403	\$ 40,806	Yardney quote, 2000, escalated	
	Differential pressure switch	0 - 30 psig	Brass	1		included above		

**Table B-7**

Alternative 4 – Plume-Wide Extraction With Reinjection

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Reverse Osmosis

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
Installation	<b>TREATMENT PLANT Equipment Material Only "B"</b>					\$ 6,680,208	
	<b>Labor For Equipment Installation</b>					\$ 1,336,042	
	<b>TREATMENT PLANT SUBTOTAL "B"</b>					<b>\$ 8,016,249</b>	
	Site work			5.0%	of Subtotal "B"	\$ 400,812	
	Mechanical Piping			15.0%	of Subtotal "B"	\$ 1,202,437	
	I&C			10.0%	of Subtotal "B"	\$ 801,625	
	Electrical			10.0%	of Subtotal "B"	\$ 801,625	
	Common Facilities			8.0%	of Subtotal "B"	\$ 641,300	
	Building--Office/Control Room/Lab/Restroom		Pre Fab Office	1	\$ 62,000	\$ 62,000	800 sf Pre Fab Office
	Metals			5.0%	of Subtotal "B"	\$ 400,812	
	RO Concrete Slab and Roof Structure			2500	\$ 42	\$ 105,000	
	<b>TREATMENT PLANT SUBTOTAL "C"</b>					<b>\$ 12,431,861</b>	
	Engineering- Design and Technical Support			8%		\$ 994,549	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 1,864,779	
	Contractors Profit			8%		\$ 1,143,731	
	Construction Management			5%		\$ 772,019	
	Construction Contingency			25%		\$ 4,053,098	
	LACSD Sewer Connection Fee			Lump		\$ 7,485,804	
	<b>TOTAL TREATMENT PLANT COST</b>					<b>\$ 28,745,800</b>	
	<b>GRAND TOTAL CONVEYANCE, WELL SYSTEM AND TREATMENT PLANT COST</b>					<b>\$ 41,355,500</b>	
NOTES:							
1. All equipment cost adjustments for size based on the formula: Adjusted Cost = Orig. Cost * (Adjusted Size/Orig. Size) EXP X							
where "X" is 0.33 for pumps, 0.57 for Tanks, 0.62 for towers, and 0.6 for other process equipment.							
2. Cost escalation adjustments from the following time periods were used, if needed, as appropriate.							
<b>Escalation Factors</b>							
2000-2009: 36.02%							
2003-2009: 31.61%							
2004-2009: 25.74%							
2005-2009: 17.72							
2006-2009: 4.21%							



**Table B-8**

Alternative 4 – Plume-Wide Extraction With Reinjection  
Operations and Maintenance Cost Estimate Summary  
Feasibility Study, Omega Chemical Superfund Site OU2  
Design Flow-2000 GPM; Avg. Flow-1300 gpm

**Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Reverse Osmosis**

O&M Category	Equip. Name	Equip. Description	O&M Requirement per Unit	Number of Units	Total Requirements	Units	Unit Cost	Cost
<b>Electrical Power</b>	LE Well Pumps to Treatment Plant	235 gpm @ 300'	145,940	3	437,819	kW-hr		
	CE Wells Pumps to Treatment Plant	170 gpm @ 250'	87,978	2	175,955	kW-hr		
	LE Wells Pumps to Treatment Plant	170 gpm @ 270'	95,016	2	190,032	kW-hr		
	Treatment Plant Feed Pump	1300 gpm @ 200'	538,217	1	538,217	kW-hr		
	Advanced Oxidation Process (kw)	93.1	858,480	1	858,480	kW-hr		
	RO System(1300 gpm avg flow)	1300 gpm @ 700'	1,883,758	1	1,883,758	kW-hr		
	Reject Brine Pump	325 gpm @ 60'	40,366	1	40,366	kW-hr		
	Treated Water Pump to Inj Wells	975 gpm @ 15'	30,275	1	30,275	kW-hr		
	Backwash Decant Pump	200 gpm @ 30', 10% time	1,242	1	1,242	kW-hr		
	LGAC Backwash Pumps	1100 gpm @ 75', 1%	1,708	2	3,416	kW-hr		
	Misc. Controls/Lights (allowance)	1,500 W	16,466	1	16,466	kW-hr		
	<b>Total</b>				4,176,025	kW-hr	\$ 0.12	\$ 501,123
<b>Carbon Make-up</b>	LGAC	920 lb/day	335,800	1	335,800	lb C	\$ 1.00	\$ 335,800
<b>Chemicals/Materials</b>	Ion Exchange Resin	NA		1	0		\$ 145.00	\$ -
	Hydrogen Peroxide (AOP Process)	25 ppm	142293	1	142293	lb	\$ 1.00	\$ 142,293
	Sodium metabisulfite	6 ppm	34150	1	34150	lb	\$ 1.00	\$ 34,150
	NF or RO Operations (CIP, consumables, etc.)	\$0.26/1000 gal	\$ 177,653	1	163987	yr		\$ 163,987
	H2SO4 (for pH Adjustment)	NA			-	lb	\$ 0.15	\$ -
	NaOH (for pH Adjustment)	NA			-	lb dry	\$ 0.11	\$ -
	Sodium Hypochlorite	NA		1	-	lb	\$ 0.50	\$ -
	Filter Bags	Weekly bag replacement	104	1	104	ea	\$ 70.00	\$ 7,280
	RO biocide (incl with RO consumables)							
	Polymer (for backwash system/sludge filter)	Negligible			1		25,000	\$ 25,000
	Inj well chemicals	Allowance	lump sum					
	UV Lamp Replacement		\$ 66,100	1	1	\$	66,100	\$ 66,100
<b>Residuals Disposal</b>	LGAC	Included above						
	Backwash Sludge Cake (allowance)	1% of carbon as 30% sludge	5.6	1	5.6	tons	\$ 500.00	\$ 2,798
	Ion Exchange Resin	Included above						
<b>Analytical</b>	Treatment Plant	Effluent	Weekly	52		ea	\$ 300.00	\$ 15,600
	Extraction Wells	7 wells	Quarterly	28		ea	\$ 300.00	\$ 8,400
	Monitoring Wells	10 MWs @ 4 ports ea	Semiannual/Annual	80		ea	\$ 300.00	\$ 24,000
	Water Samples - Additional Annual Tests-allowance			6		ea.	\$ 1,000.00	\$ 6,000
<b>Labor</b>	Well Operating	2 Hr/day		730		hrs	\$ 45.00	\$ 32,850
	Well Maintenance	3 Hr/day		1095		hrs	\$ 45.00	\$ 49,275
	Operating--GWTP	8 Hrs /day		2920		hrs	\$ 45.00	\$ 131,400
	Maintenance-GWTP	8 Hrs/day		2920		hrs	\$ 45.00	\$ 131,400
	Supervisory	4 Hrs/day		1460		hrs	\$ 50.00	\$ 73,000
	Clerical	3 Hrs/day		1095		hrs	\$ 20.00	\$ 21,900

**Table B-8**

Alternative 4 – Plume-Wide Extraction With Reinjection  
 Operations and Maintenance Cost Estimate Summary  
 Feasibility Study, Omega Chemical Superfund Site OU2  
 Design Flow-2000 GPM; Avg. Flow-1300 gpm

**Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Reverse Osmosis**

O&M Category	Equip. Name	Equip. Description	O&M Requirement per Unit	Number of Units	Total Requirements	Units	Unit Cost	Cost
<b>Subcontracts</b>								
	Monitoring Wells Sampling (Subcontract)			1		lot	\$ 90,000.00	\$ 90,000
	Regulatory Monitoring reports allowance (RWQCB, EPA, Air Emissions Inventory)			1		lot	\$ 25,000.00	\$ 25,000
<b>Parts</b>								
	2% of TP Capital				2%		\$ 12,431,861	\$ 248,637
								\$ 2,168,000
<b>Contingency on Materials/Services</b>					10%			\$ 216,800
<b>LACSD Annual Sewer Surcharge</b>			Annual	1			\$ 179,097	\$ 179,097
<b>GRAND TOTAL</b>								<b>\$ 2,563,897</b>

Table B-9

Alternative 5 – Plume-wide Extraction With Discharge To Spreading Basins

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2200 GPM; Avg. Flow-1300 gpm (about 10% higher flow due to spreading basin downtime for maintenance &amp; cleaning) Increase Design flow to 2200 gpm due to basin unavailability

Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
<b>CONVEYANCE &amp; WELL SYSTEM COSTS</b>							
<b>Water Pipelines (base)</b>							
<b>gpm</b>							
375	LE Extraction Segment 1	6	CML DI	900	\$ 50.00	\$ 45,000	
750	LE Extraction Segment 2	8	CML DI	500	\$ 55.80	\$ 27,900	
1,125	LE Extraction Segment 3	12	CML DI	14700	\$ 81.65	\$ 1,200,255	
540	CE Extracted Water Pipeline	8	CML DI	4500	\$ 55.80	\$ 251,100	
540	NE Extracted Water Pipeline	8	CML DI	6100	\$ 55.80	\$ 340,380	
275	Brine Line to Indust Sewer Tie-In(@Florence)	6	CML DI	6000	\$ 50.00	\$ 300,000	
1,925	Treated Water to San Gabriel River	14	CML DI	9200	\$ 95.88	\$ 882,096	
	Freeway Crossing w/14" HDPE	14" in single boring	HDPE	500	\$ 406.20	\$ 203,098	
	Bore & Jack Railroad Crossing	8" pipeline in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
	Bore & Jack Railroad Crossing	8" pipeline in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
<b>Extraction Wells</b>							
	New EW system at LE	3 @ 375 gpm ea X 200'		3	\$ 241,418	\$ 724,255	See Table B-15
	New EW system at LE	2 @ 270 gpm ea X 200'		2	\$ 241,418	\$ 482,836	See Table B-15
	New EW system at LE	2 @ 270 gpm ea X 200'		2	\$ 241,418	\$ 482,836	See Table B-15
	Investigation Derived Waste Mgmt			7	\$ 35,260	\$ 246,817	See Table B-15
<b>New Monitoring Wells</b>							
	New Monitoring Wells	10 w/4 screened well intervals ea; ___" dia x ___ft		10	\$ 72,800	\$ 728,000	See Table B-13
	Investigation Derived Waste Mgmt			10	\$ 35,260	\$ 352,595	See Table B-15
<b>Extraction Well Pumps and Well Head Ancillaries</b>							
	New EW systems	Pumps, Vaults, Valves, Gauges, Flow meters/totalizers, relief valves, power supply, etc.)		7	\$ 133,024	\$ 931,165	See Table B-15
<b>CONVEYANCE &amp; WELL SYSTEM SUBTOTAL A</b>						<b>\$ 7,462,388</b>	
	Engineering- Design and Technical Support			8%		\$ 596,991	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 1,119,358	
	Contractors Profit			8%		\$ 686,540	
	Construction Management			5%		\$ 463,414	
	Construction Contingency			25%		\$ 2,582,173	
<b>Conveyance and Extraction Well System Cost</b>						<b>\$ 12,910,900</b>	
<b>GROUNDWATER TREATMENT PLANT</b>							
<b>Untreated Water Tank</b>							
	Holding Tank	6,000 gallon	CS, Epoxy coated	1	\$ 35,590	\$ 35,590	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
<b>Treatment Plant Feed Pump</b>							
	Feed Pump	2200 gpm @ 250 ft H2O	CI/SS trim	2	\$ 75,709	\$ 151,418	Johnson pump, 2003, prorated, escalated
	Flow indicating totalizer	8-inch		1	\$ 4,000	\$ 4,000	
<b>Bag Filter System</b>							
	Bag Filters	2200 gpm	CS, Epoxy coated	2	\$ 20,403	\$ 40,806	Yardney quote, 2000, escalated
	Differential pressure switch	0 - 30 psig	Brass	1		included above	
<b>Inline Mixer-Acid Injection Injection</b>							
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	CH2M estimate

**Table B-9**

Alternative 5 – Plume-wide Extraction With Discharge To Spreading Basins

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2200 GPM; Avg. Flow-1300 gpm (about 10% higher flow due to spreading basin downtime for maintenance &amp; cleaning) Increase Design flow to 2200 gpm due to basin unavailability

**Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis**

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source	
Sulfuric Acid System	-- Storage Tank	10,000 gal	CS	1	\$ 47,619	\$ 47,619	RS Means 2009, Prorated	
	-- Tank level switch			1	\$ 365	\$ 365		
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000		
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000		
Ion Exchange System	Resin adsorber columns (2 pair)	Lead/lag config; 12' Dia ea.; 350 cu.ft. resin ea vessel		4	\$ 342,639	\$ 1,370,558	US Filter 2004,prorated,escalated	
	Initial Resin Charge	8 vessels @ 350 cu.ft. ea	Cu. FT of resin	2800	\$ 418.71	\$ 1,172,400		Escalated from 2004
Inline Mixer-Sodium Hydroxide Injection	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	CH2M estimate	
Caustic System	-- Storage Tank	15,000 gal	CS	1	\$ 60,000	\$ 60,000	RS Means 2009, Prorated	
	-- Tank level switch			1	\$ 365	\$ 365		
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000		
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000		
Advanced Oxidation Process (AOP)--Trojan System	AOP System (1,400 gpm, 18.5 kW)	2200 gpm; Infl 1,4-dioxane @ 13.2 ppb to <2 ppb design; 53.3 kw reqd, use 3 std 18.5 kw modules					542,254	Prorated, Escalated Trojan Quote, 2004
	-- ASME Code vessels		CS	1	\$ 542,254			
	-- UV Light System (72 lamps)		Quartz/SS/Teflon		included			
	-- Piping inside AOP system		SS		included			
	-- Graphic Control Panel				included			
	Peroxide Feed System							
	-- Holding Tank	10,000 gal	FRP	1	\$ 47,619	\$ 47,619	RS Means 2009, Prorated	
	-- Tank level switch			1	\$ 365	\$ 365		
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000		
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000		
-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000			
Sodium Metabisulfite Injection	-- carboy			1		\$ -	Provided by supplier	
	-- Tank level switch			1	\$ 365	\$ 365		
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000		
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000		
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000		
Biological LGAC Adsorber System	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS each	CS, Epoxy coated	2.5	\$ 177,674	\$ 444,184	Vendor Quote (Calgon), 2003,escalated	
	Differential Pressure Switch	0-30 psig	Brass	5	\$ 590	\$ 2,950		
	Flow indicating totalizer	8-inch		7	\$ 4,000	\$ 28,000		
LGAC Adsorber System	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS each	CS, Epoxy coated	5	\$ 177,674	\$ 888,368	Vendor Quote (Calgon), 2003,escalated	
	Differential Pressure Switch	0-30 psig	Brass	10	\$ 590	\$ 5,900		
	Flow indicating totalizer	8-inch		12	\$ 4,000	\$ 48,000		
	BW and Rinse Recovery						RS Means 2009, Prorated	
	-- Sloped bottom holding tank	30,000 gal	FRP	1	\$ 77,111	\$ 77,111		
	-- VGAC Drum			1	\$ 300	\$ 300		
	-- Diaphragm-type sludge pump			2	\$ 2,000	\$ 4,000		
	-- Polymer tank with mixer	50 gal	SS	1	\$ 3,845	\$ 3,845	Means 2009	
	-- Polymer feed pump	10 gph	316 SS	2	\$ 10,000	\$ 20,000		
	-- Tank level switch			1	\$ 1,500	\$ 1,500		
	-- Backwash Tank Decant Pump			1	\$ 3,000	\$ 3,000		
	-- Backwash Pump	950 gpm, 15 hp		1	\$ 8,825	\$ 8,825	Vendor Quote (US Filter), 2004, prorated,escalated	
	-- Plate and frame filter press	5 cu. ft..	PVC	1	\$ 56,583	\$ 56,583		

Table B-9

Alternative 5 – Plume-wide Extraction With Discharge To Spreading Basins

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2200 GPM; Avg. Flow-1300 gpm (about 10% higher flow due to spreading basin downtime for maintenance &amp; cleaning) Increase Design flow to 2200 gpm due to basin unavailability

Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
Biocide Injection	-- carboy			1		\$ -	Provided by supplier
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
RO Feed Tank							
	Tank @ 10 Min. ret time	20,000 gallon	CS, Epoxy coated	1	\$ 70,691	\$ 70,691	RS Means 2009, Prorated
Level Switch			1	\$ 365	\$ 365		
Reverse Osmosis System							
	RO System (75% Recovery)	1100 gpm	\$1.40/gpd	1	\$ 2,217,600	\$ 2,217,600	
	-- ASME Code vessels						
	-- 2-to-1 Tapered array						
	-- Booster pumps						
	-- CIP System						
	-- PLC Control system						
	-- pH Adjustment/Antiscalent Injection systems						
	-- Feed Pumps						
	-- Cartridge Filters						
	-- RO Reject Brine Pump( to sewer)	275 gpm @ 220 ft H2O		2	\$ 36,543	\$ 73,087	Johnson pump, 2003, prorated, escalated
	-- Flow indicating totalizer			1	\$ 4,000	\$ 4,000	
Treated Water Tank							
	Holding Tank	30,000 gallon	CS, Epoxy coated	1	\$ 89,071	\$ 89,071	RS Means 2009, Prorated
Level Switch			1	\$ 365	\$ 365		
Treated Water Pump							
	Treated Water Pump	2000 gpm @ 120 ft H2O	Cl/SS trim	2	\$ 57,584	\$ 115,167	Johnson pump, 2003, prorated, escalated
Flow indicating totalizer			1	\$ 4,000	\$ 4,000		
Installation	TREATMENT PLANT Equipment Material Only "B"					\$ 7,806,365	
	Labor For Equipment Installation					\$ 1,561,273	
	TREATMENT PLANT SUBTOTAL "B"					\$ 9,367,637	
	Sitework			5.0%	of Subtotal "B"	\$ 468,382	
	Mechanical Piping			15.0%	of Subtotal "B"	\$ 1,405,146	
	I&C			10.0%	of Subtotal "B"	\$ 936,764	
	Electrical			10.0%	of Subtotal "B"	\$ 936,764	
	Common Facilities			8.0%	of Subtotal "B"	\$ 749,411	
	Building--Office/Control Room/Lab/Restroom			1	\$ 62,000	\$ 62,000	800 sf Pre Fab Office
	Metals			5.0%	of Subtotal "B"	\$ 468,382	
	RO Concrete Slab and Roof Structure			1000	\$ 42	\$ 42,000	
	TREATMENT PLANT SUBTOTAL "C"					\$ 14,436,485	
	Engineering- Design and Technical Support			8%		\$ 1,154,919	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 2,165,473	
	Contractors Profit			8%		\$ 1,328,157	
	Construction Management			5%		\$ 896,506	
	Construction Contingency			25%		\$ 4,995,385	
	LACSD Sewer Connection Fee			Lump		\$ 3,742,902	

**Table B-9**

Alternative 5 – Plume-wide Extraction With Discharge To Spreading Basins

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2200 GPM; Avg. Flow-1300 gpm (about 10% higher flow due to spreading basin downtime for maintenance &amp; cleaning) Increase Design flow to 2200 gpm due to basin unavailability

**Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis**

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
	<b>TOTAL TREATMENT PLANT COST</b>					<b>\$ 28,719,800</b>	
	<b>GRAND TOTAL CONVEYANCE, WELL SYSTEM AND TREATMENT PLANT COST</b>					<b>\$ 41,630,700</b>	

**NOTES:**

- All equipment cost adjustments for size based on the formula: Adjusted Cost = Orig. Cost \* (Adjusted Size/Orig. Size) EXP X  
where "X" is 0.33 for pumps, 0.57 for Tanks, 0.62 for towers, and 0.6 for other process equipment.
- Cost escalation adjustments from the following time periods were used, if needed, as appropriate.

**Escalation Factors**

2000-2009: 36.02%

2003-2009: 31.61%

2004-2009: 25.74%

2005-2009: 17.72

2008-2009: 4.21%

Table B-10

Alternative 5 – Plume-wide Extraction With Discharge To Spreading Basins

Operations and Maintenance Cost Estimate Summary

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2200 GPM; Avg. Flow-1300 gpm

Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis

O&M Category	Equip. Name	Equip. Description	O&M Requirement per Unit	Number of Units	Total Requirements	Units	Unit Cost	Cost
Electrical Power	LE Well Pumps to Treatment Plant	235 gpm @ 300'	145,940	3	437,819	kW-hr		
	CE Wells Pumps to Treatment Plant	170 gpm @ 250'	87,978	2	175,955	kW-hr		
	LE Wells Pumps to Treatment Plant	170 gpm @ 270'	95,016	2	190,032	kW-hr		
	Treatment Plant Feed Pump	1300 gpm @ 270'	726,592	1	726,592	kW-hr		
	Advanced Oxidation Process (kw)	31.5	290,463	1	290,463	kW-hr		
	RO System(650 gpm avg flow)	650 gpm @ 700'	941,879	1	941,879	kW-hr		
	Reject Brine Pump	160 gpm @ 76'	25,172	1	25,172	kW-hr		
	Treated Water Pump to San Gabriel River	1140 gpm @ 100'	235,987	1	235,987	kW-hr		
	Backwash Decant Pump	200 gpm @ 30', 10% time	1,242	1	1,242	kW-hr		
	LGAC Backwash Pumps	1100 gpm @ 75', 1%	1,708	2	3,416	kW-hr		
	Misc. Controls/Lights (allowance)	1,500 W	16,466	1	16,466	kW-hr		
	<b>Total</b>				3,045,024	kW-hr	\$ 0.12	\$ 365,403
Carbon Make-up	LGAC	940 lb/day	343,100	1	343,100	lb C	\$ 1.00	\$ 343,100
Chemicals/Materials	Ion Exchange Resin	950 cu. ft./yr	950	1	950	cu. ft.	\$ 595.51	\$ 565,735
	Hydrogen Peroxide (AOP Process)	25 ppm	142293	1	142,293	lb	\$ 1.00	\$ 142,293
	Sodium metabisulfite	6 ppm	34150	1	34150	lb	\$ 1.00	\$ 34,150
	NF or RO Operations (CIP, consumables, etc.)	\$0.26/1000 gal	177,653	1	177,653	yr	\$	\$ 177,653
	H2SO4 (for pH Adjustment)	215 ppm dosage	1223720	1	1,223,720	lb	\$ 0.15	\$ 183,558
	NaOH (for pH Adjustment)	175 ppm dosage	996051	1	996,051	lb dry	\$ 0.11	\$ 109,566
	Sodium Hypochlorite	3 ppm total dosage	17,096	1	17,096	lb	\$ 0.50	\$ 8,548
	Filter Bags	Weekly bag replacement	104	1	104	ea	\$ 70.00	\$ 7,280
	RO biocide (incl with RO consumables)							
	Polymer (for backwash system/sludge filter)	Negligible						
	UV Lamp Replacement		\$ 22,400	1	1	\$	22,400	\$ 22,400
Residuals Disposal	LGAC	Included above						
	Backwash Sludge Cake (allowance)	1% of carbon as 30% sludge	5.7	1	5.7	tons	\$ 500.00	\$ 2,859
	Ion Exchange Resin	Included above						
Analytical	Treatment Plant	Effluent	Weekly	52		ea	\$ 300.00	\$ 15,600
	Extraction Wells	7 wells	Quarterly	28		ea	\$ 300.00	\$ 8,400
	Monitoring Wells	10 MWs @ 4 ports ea	Semiannual/Annual	80		ea	\$ 300.00	\$ 24,000
	Water Samples - Additional Annual Tests-allowance			6		ea.	\$ 1,000.00	\$ 6,000
Labor	Well Operating	2 Hr/day		730		hrs	\$ 45.00	\$ 32,850
	Well Maintenance	2 Hr/day		730		hrs	\$ 45.00	\$ 32,850
	Operating--GWTP	12 Hrs /day		4380		hrs	\$ 45.00	\$ 197,100
	Maintenance-GWTP	8 Hrs/day		2920		hrs	\$ 45.00	\$ 131,400
	Supervisory	4 Hrs/day		1460		hrs	\$ 50.00	\$ 73,000
	Clerical	3 Hrs/day		1095		hrs	\$ 20.00	\$ 21,900

**Table B-10**

Alternative 5 – Plume-wide Extraction With Discharge To Spreading Basins

Operations and Maintenance Cost Estimate Summary

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2200 GPM; Avg. Flow-1300 gpm

**Process Scheme: Ion /Exchange, Advanced Oxidation, Biological LGAC, LGAC, Reverse Osmosis**

<u>O&amp;M Category</u>	<u>Equip. Name</u>	<u>Equip. Description</u>	<u>O&amp;M Requirement per Unit</u>	<u>Number of Units</u>	<u>Total Requirements</u>	<u>Units</u>	<u>Unit Cost</u>	<u>Cost</u>
<b>Subcontracts</b>								
	Monitoring Wells Sampling (Subcontract)			1		lot	\$ 90,000.00	\$ 90,000
	Regulatory Monitoring reports allowance (RWQCB, EPA, Air Emissions Inventory)			1		lot	\$ 25,000.00	\$ 25,000
<b>Parts</b>								
	2% of TP Capital				2%		\$ 14,436,485	\$ 288,730
								\$ 2,941,000
<b>Contingency on Materials/Services</b>					10%			\$ 294,100
<b>LACSD Annual Sewer Surcharge</b>			Annual	1			\$ 89,530	\$ 89,530
<b>GRAND TOTAL</b>								<b>\$ 3,324,630</b>

Table B-11

Alternative 6 – Plume-Wide Extraction With Drinking Water End Use

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
<b>CONVEYANCE &amp; WELL SYSTEM COSTS</b>							
<b>Water Pipelines (base)</b>							
<b>gpm</b>							
350	LE Extraction Segment 1	6	CML DI	900	\$ 50.00	\$ 45,000	
700	LE Extraction Segment 2	8	CML DI	500	\$ 55.80	\$ 27,900	
1,050	LE Extraction Segment 3	12	CML DI	14700	\$ 81.65	\$ 1,200,255	
500	CE Extracted Water Pipeline	8	CML DI	4500	\$ 55.80	\$ 251,100	
500	NE Extracted Water Pipeline	8	CML DI	6100	\$ 55.80	\$ 340,380	
500	Brine Line to Indust Sewer Tie-In(@Florence)	8	CML DI	6000	\$ 55.80	\$ 334,800	
1,500	Treated Potable Water to SFS Storage Tk	14	CML DI	8000	\$ 95.88	\$ 767,040	
	Bore & Jack Railroad Crossing	8" pipeline in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
	Bore & Jack Railroad Crossing	8" pipeline in single boring		1	\$ 132,027.00	\$ 132,027	Escalated 2004 PVOU FS Cost
<b>Extraction</b>							
	New EW system at LE	3 @ 350 gpm ea X 200'		3	\$ 241,418	\$ 724,255	See Table B-15
	New EW system at CE	2 @ 250 gpm ea X 200'		2	\$ 241,418	\$ 482,836	See Table B-15
	New EW system at NE	2 @ 250 gpm ea X 200'		2	\$ 241,418	\$ 482,836	See Table B-15
	Investigation Derived Waste Mgmt			7	\$ 35,260	\$ 246,817	See Table B-15
<b>New Monitoring Wells</b>							
	New Monitoring Wells	10 w/4 screened well intervals ea; ___" dia x ___ft		10	\$ 72,800	\$ 728,000	See Table B-13
	Investigation Derived Waste Mgmt			10	\$ 35,260	\$ 352,595	See Table B-15
<b>Extraction Well Pumps and Well Head Ancillaries</b>							
	New EW systems	Pumps, Vaults, Valves, Gauges, Flow meters/totalizers, relief valves, power supply, etc.)		7	\$ 133,024	\$ 931,165	See Table B-15
<b>CONVEYANCE &amp; WELL SYSTEM SUBTOTAL A</b>						<b>\$ 7,179,034</b>	
	Engineering- Design and Technical Support			8%		\$ 574,323	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 1,076,855	
	Contractors Profit			8%		\$ 660,471	
	Construction Management			5%		\$ 445,818	
	Construction Contingency			25%		\$ 2,484,125	
<b>Conveyance and Extraction Well System Cost</b>						<b>\$ 12,420,600</b>	
<b>GROUNDWATER TREATMENT PLANT</b>							
<b>Untreated Water Tank</b>							
	Holding Tank	6,000 gallon	CS, Epoxy coated	1	\$ 35,590	\$ 35,590	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
<b>Treatment Plant Feed Pump</b>							
	Feed Pump	2000 gpm @ 250 ft H2O	Cl/SS trim	2	\$ 73,365	\$ 146,730	Johnson pump, 2003, prorated, escalated
	Flow indicating totalizer	8-inch		1	\$ 4,000	\$ 4,000	
<b>Bag Filter System</b>							
	Bag Filters	2000 gpm	CS, Epoxy coated	2	\$ 20,403	\$ 40,806	Yardney quote, 2000, escalated
	Differential pressure switch	0 - 30 psig	Brass	1		included above	
<b>Advanced Oxidation Process (AOP)--Trojan System</b>							
	AOP System	2000 gpm; Infl 1,4-dioxane @ 13.2 ppb to <2 ppb design; 48.5 kw reqd, use 3 std 18.5 kw modules					
	-- ASME Code vessels		CS	1	\$ 542,254	\$ 542,254	Prorated, Escalated Trojan Quote, 2004
	-- UV Light System (72 lamps)		Quartz/SS/Teflon		included		
	-- Piping inside AOP system		SS		included		
	-- Graphic Control Panel				included		

Table B-11

Alternative 6 – Plume-Wide Extraction With Drinking Water End Use

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
	Peroxide Feed System						
	-- Holding Tank	10,000 gal	FRP	1	\$ 47,619	\$ 47,619	RS Means 2009, Prorated
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
Sodium Metabisulfite Injection							
	-- carboy			1		\$ -	Provided by supplier
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
Biological LGAC Adsorber System							
	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS each	CS, Epoxy coated	2.5	\$ 177,674	\$ 444,184	Vendor Quote (Calgon), 2003,escalated
	Differential Pressure Switch	0-30 psig	Brass	5	\$ 590	\$ 2,950	
	Flow indicating totalizer	8-inch		7	\$ 4,000	\$ 28,000	
LGAC Adsorber System							
	LGAC adsorber columns (1 pair)	20,000 lbs, 120"Dia x 144"SS each	CS, Epoxy coated	5	\$ 177,674	\$ 888,368	Vendor Quote (Calgon), 2003,escalated
	Differential Pressure Switch	0-30 psig	Brass	10	\$ 590	\$ 5,900	
	Flow indicating totalizer	8-inch		12	\$ 4,000	\$ 48,000	
	BW and Rinse Recovery						
	-- Sloped bottom holding tank	30,000 gal	FRP	1	\$ 77,111	\$ 77,111	RS Means 2009, Prorated
	-- VGAC Drum			1	\$ 300	\$ 300	
	-- Diaphragm-type sludge pump			2	\$ 2,000	\$ 4,000	
	-- Polymer tank with mixer	50 gal	SS	1	\$ 3,845	\$ 3,845	20,000
	-- Polymer feed pump	10 gph	316 SS	2	\$ 10,000	\$ 20,000	
	-- Tank level switch			1	\$ 1,500	\$ 1,500	
	-- Backwash Tank Decant Pump			1	\$ 3,000	\$ 3,000	Means 2009
	-- Backwash Pump	950 gpm, 15 hp		1	\$ 8,825	\$ 8,825	
	-- Plate and frame filter press	5 cu. ft..	PVC	1	\$ 56,583	\$ 56,583	
							Vendor Quote (US Filter), 2004, prorated, escalated
Biocide Injection							
	-- carboy			1		\$ -	Provided by supplier
	-- Tank level switch			1	\$ 365	\$ 365	
	-- Metering Pumps	0.5 gpm	Acid Spec	2	\$ 10,000	\$ 20,000	
	-- Pulsation dampener		Acid Spec	1	\$ 3,000	\$ 3,000	
	-- Static Mixer	12-inch	Acid Spec	1	\$ 10,000	\$ 10,000	
NF Feed Tank							
	Tank @ 10 Min. ret time	20,000 gallon	CS, Epoxy coated	1	\$ 70,691	\$ 70,691	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
Nanofiltration System (NF)							
	NF System (75% Recovery)	2000 gpm	\$1.00/gpd	1	\$ 2,880,000	\$ 2,880,000	
	-- ASME Code vessels						
	-- 2-to-1 Tapered array						
	-- Booster pumps						
	-- CIP System						
	-- PLC Control system						
	-- pH Adjustment/Antiscalent Injection systems						
	-- Feed Pumps						
	-- Cartridge Filters						

Table B-11

Alternative 6 – Plume-Wide Extraction With Drinking Water End Use

Materials List and Capital Cost Table

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration

Major System	Component	Size	Material	Quantity	Unit Cost	Cost	Cost Estimate Source
	-- RO Reject Brine Pump (to sewer)	500 gpm @60 ft H2O		2	\$ 28,992	\$ 57,984	Johnson pump, 2003, prorated, escalated
	-- Flow indicating totalizer			1	\$ 4,000	\$ 4,000	
<b>Chlorination System</b>	Holding Tank, metering pumps, chlorine analyzer, mixer, etc.			Lump	\$ 85,000	\$ 85,000	
<b>Treated Water Tank</b>	Holding Tank	30,000 gallon	CS, Epoxy coated	1	\$ 89,071	\$ 89,071	RS Means 2009, Prorated
	Level Switch			1	\$ 365	\$ 365	
<b>Treated Water Pump</b>	Treated Water Pump	1500 gpm @ 120 ft H2O	Cl/SS trim	2	\$ 52,368	\$ 104,737	Johnson pump, 2003, prorated, escalated
	Flow indicating totalizer			1	\$ 4,000	\$ 4,000	
<b>Installation</b>	<b>TREATMENT PLANT Equipment Material Only "B"</b>					\$ 5,806,237	
	<b>Labor For Equipment Installation</b>					\$ 1,161,247	
	<b>TREATMENT PLANT SUBTOTAL "B"</b>					<b>\$ 6,967,484</b>	
	Site work			5.0%	of Subtotal "B"	\$ 348,374	
	Mechanical Piping			15.0%	of Subtotal "B"	\$ 1,045,123	
	I&C			10.0%	of Subtotal "B"	\$ 696,748	
	Electrical			10.0%	of Subtotal "B"	\$ 696,748	
	Common Facilities			8.0%	of Subtotal "B"	\$ 557,399	
	Building--Office/Control Room/Lab/Restroom		Pre Fab Office	1	\$ 62,000	\$ 62,000	800 sf Pre Fab Office
	Metals			5.0%	of Subtotal "B"	\$ 348,374	
	RO Concrete Slab and Roof Structure			2500	\$ 42	\$ 105,000	
	<b>TREATMENT PLANT SUBTOTAL "C"</b>					<b>\$ 10,827,251</b>	
	Engineering- Design and Technical Support			8%		\$ 866,180	
	Contractors Overhead, General Conditions, Mob/Demob, Temp Facilities			15%		\$ 1,624,088	
	Contractors Profit			8%		\$ 996,107	
	Construction Management			5%		\$ 672,372	
	Construction Contingency			25%		\$ 3,529,955	
	LACSD Sewer Connection Fee			Lump		\$ 7,485,804	
	<b>TOTAL TREATMENT PLANT COST</b>					<b>\$ 26,001,800</b>	
	<b>GRAND TOTAL CONVEYANCE, WELL SYSTEM AND TREATMENT PLANT COST</b>					<b>\$ 38,422,400</b>	

## NOTES:

- All equipment cost adjustments for size based on the formula: Adjusted Cost = Orig. Cost \* (Adjusted Size/Orig. Size) EXP X where "X" is 0.33 for pumps, 0.57 for Tanks, 0.62 for towers, and 0.6 for other process equipment.
- Cost escalation adjustments from the following time periods were used, if needed, as appropriate.

**Escalation Factors**

2000-2009: 36.02%  
2003-2009: 31.61%  
2004-2009: 25.74%  
2005-2009: 17.72  
2008-2009: 4.21%



Table B-12

Alternative 6 – Plume-Wide Extraction With Drinking Water End Use  
 Operations and Maintenance Cost Estimate Summary  
 Feasibility Study, Omega Chemical Superfund Site OU2  
 Design Flow-2000 GPM; Avg. Flow-1300 gpm

Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration

O&M Category	Equip. Name	Equip. Description	O&M Requirement per Unit	Number of Units	Total Requirements	Units	Unit Cost	Cost
Electrical Power	LE Well Pumps to Treatment Plant	235 gpm @ 300'	145,940	3	437,819	kW-hr		
	CE Wells Pumps to Treatment Plant	170 gpm @ 250'	87,978	2	175,955	kW-hr		
	LE Wells Pumps to Treatment Plant	170 gpm @ 270'	95,016	2	190,032	kW-hr		
	Treatment Plant Feed Pump	1300 gpm @ 200'	538,217	1	538,217	kW-hr		
	Advanced Oxidation Process (kw)	31.5	290,463	1	290,463	kW-hr		
	NF System(1300 gpm avg flow)	1300 gpm @ 700'	1,883,758	1	1,883,758	kW-hr		
	Reject Brine Pump	325 gpm @ 60'	40,366	1	40,366	kW-hr		
	Treated Water Pump to SFS PW Tank	975 gpm @ 120'	242,197	1	242,197	kW-hr		
	Backwash Decant Pump	200 gpm @ 30', 10% time	1,242	1	1,242	kW-hr		
	LGAC Backwash Pumps	1100 gpm @ 75', 1%	1,708	2	3,416	kW-hr		
	Misc. Controls/Lights (allowance)	1,500 W	16,466	1	16,466	kW-hr		
	<b>Total</b>				3,819,931	kW-hr	\$ 0.12	\$ 458,392
Carbon Make-up	LGAC	920 lb/day	335,800	1	335,800	lb C	\$ 1.00	\$ 335,800
Chemicals/Materials	Ion Exchange Resin	NA		1	0		\$ 145.00	\$ -
	Hydrogen Peroxide (AOP Process)	25 ppm	142293	1	142293	lb	\$ 1.00	\$ 142,293
	Sodium metabisulfite	6 ppm	34150	1	34150	lb	\$ 1.00	\$ 34,150
	NF or RO Operations (CIP, consumables, etc.)	\$0.26/1000 gal	\$ 177,653	1	163987	yr		\$ 163,987
	H2SO4 (for pH Adjustment)	NA			-	lb	\$ 0.15	\$ -
	NaOH (for pH Adjustment)	NA			-	lb dry	\$ 0.11	\$ -
	Sodium Hypochlorite	NA		1	-	lb	\$ 0.50	\$ -
	Filter Bags	Weekly bag replacement	104	1	104	ea	\$ 70.00	\$ 7,280
	NF biocide (incl with NF consumables)							
	Polymer (for backwash system/sludge filter)	Negligible			1		25,000	\$ 25,000
	Inj well chemicals	Allowance	lump sum					
	UV Lamp Replacement		\$ 22,400	1	1	\$	66,100	\$ 66,100
Residuals Disposal	LGAC	Included above						
	Backwash Sludge Cake (allowance)	1% of carbon as 30% sludge	5.6	1	5.6	tons	\$ 500.00	\$ 2,798
	Ion Exchange Resin	Included above						
Analytical	Treatment Plant	Effluent	Weekly	52		ea	\$ 300.00	\$ 15,600
	Extraction Wells	7 wells	Quarterly	28		ea	\$ 300.00	\$ 8,400
	Monitoring Wells	10 MWs @ 4 ports ea	Semiannual/Annual	80		ea	\$ 300.00	\$ 24,000
	Water Samples - Additional Annual Tests-allowance			6		ea.	\$ 1,000.00	\$ 6,000
Labor	Well Operating	2 Hr/day		730		hrs	\$ 45.00	\$ 32,850
	Well Maintenance	3 Hr/day		1095		hrs	\$ 45.00	\$ 49,275
	Operating--GWTP	8 Hrs /day		2920		hrs	\$ 45.00	\$ 131,400
	Maintenance-GWTP	8 Hrs/day		2920		hrs	\$ 45.00	\$ 131,400
	Supervisory	4 Hrs/day		1460		hrs	\$ 50.00	\$ 73,000
	Clerical	3 Hrs/day		1095		hrs	\$ 20.00	\$ 21,900

**Table B-12**

Alternative 6 – Plume-Wide Extraction With Drinking Water End Use

Operations and Maintenance Cost Estimate Summary

Feasibility Study, Omega Chemical Superfund Site OU2

Design Flow-2000 GPM; Avg. Flow-1300 gpm

**Process Scheme: Advanced Oxidation, Bio LGAC, LGAC, Nanofiltration**

<u>O&amp;M Category</u>	<u>Equip. Name</u>	<u>Equip. Description</u>	<u>O&amp;M Requirement per Unit</u>	<u>Number of Units</u>	<u>Total Requirements</u>	<u>Units</u>	<u>Unit Cost</u>	<u>Cost</u>
<b>Subcontracts</b>								
	Monitoring Wells Sampling (Subcontract)			1		lot	\$ 90,000.00	\$ 90,000
	Regulatory Monitoring reports allowance (RWQCB, EPA, Air Emissions Inventory)			1		lot	\$ 25,000.00	\$ 25,000
<b>Parts</b>								
	2% of TP Capital				2%		\$ 10,827,251	\$ 216,545
								\$ 2,093,000
<b>Contingency on Materials/Services</b>					10%			\$ 209,300
<b>LACSD Annual Sewer Surcharge</b>			Annual	1			\$ 179,097	\$ 179,097
<b>GRAND TOTAL</b>								<b>\$ 2,481,397</b>

**Table B-13**

Materials List and Capital Cost Estimate Summar  
Feasibility Study, Omega Chemical Superfund Site OU2  
Monitoring Well Installation – Four 2" Screens in One Borehole

Component	Quantity	Units	Unit Cost	Cost	Comments/Assumptions
<b>Mobilization and Cleanup</b>					
Mobilization, set up, and removal of drill rig and all ancillary equipment for drilling, completion and well development for a monitoring wells.					
On and off site	0.50	LS	\$ 11,166	\$ 5,583	assume shallow and intermediate injection system monitoring wells will be installed during same mobilization
Between wells	1	LS	\$ 2,016	\$ 2,016	
Set up and remove a hot water/high pressure wash equipment decontamination station.	1	LS	\$ 1,050	\$ 1,050	
Decontaminate drill rods, bits, and ancillary equipment. Includes containment and disposal of fluids and solids.	1	LS	\$ 525	\$ 525	
Noise Control	1	LS	\$ 2,625	\$ 2,625	
Traffic Control	1	EA	\$ 2,835	\$ 2,835	
<b>Drilling and Development</b>					
Provide and install 14" diameter conductor casing and sanitary seal in 18 " diameter boring. Includes containment for up to 40 days and disposal of drill cuttings as non-hazardous waste.	25	LF	\$ 134	\$ 3,360	25 feet per well
12-inch diameter borehole, single pass; includes containment for up to 40 days and disposal of drilling mud and cuttings as non-hazardous wastes.	250	LF	\$ 57	\$ 14,175	total well depths plus 15 feet
Complete geophysical log suite, include caliper.	1	LS	\$ 2,720	\$ 2,720	
Plug back pilot hole with bentonite-sand mixture, per LF placed.	10	LF	\$ 95	\$ 945	assume 10 feet per well
2" diameter, sch. 40 mild or low carbon steel casing, installed	625	LF	\$ 12	\$ 7,219	four 2" casings; well at each location is 330 feet, incl. 5' ss casing below and 10' above and 20 foot screen
2" diameter, schedule 10S stainless steel, installed	60	LF	\$ 35	\$ 2,079	see above comment
2" diameter, schedule 10S stainless steel, wire wrapped well screen, installed	0	LF	\$ 40	\$ -	20 feet per well
Sand filter pack, placed.	60	LF	\$ 6	\$ 378	10 feet above and below, 20-foot of screen
Furnish and install bentonite-sand annular seal.	150	LF	\$ 6	\$ 945	5 feet per well
Cement grout, placed.	40	LF	\$ 6	\$ 252	
Well Development: Fully develop wells	32	HR	\$ 105	\$ 3,360	1.35 hours/foot of screen from MW4-21 in Whittier Narrows
Below-grade surface closure	1	EA	\$ 578	\$ 578	
<b>Dedicated Sampling Pump</b>					
QED T1200M bladder pumps (4 total) with tubing, wellhead, fittings	1	EA	\$ 9,515	\$ 9,515	(compressor and control box not included)
	0	LS	\$ -	\$ -	
	0	LF	\$ -	\$ -	
	0	EA	\$ -	\$ -	
	0	LF	\$ -	\$ -	
<b>PER WELL COST</b>				<b>\$ 72,800</b>	Rounded to the nearest hundred dollars



**Table B-14**

Summary of Conveyance Pipelines of Active Remedial Alternatives  
Feasibility Study, Omega Chemical Superfund Site OU2

Remedial Alternatives	Pipeline Segment Description	Pipeline Beginning Location	Pipeline Ending Location	Approx. Pipeline Length (feet)	Avg. Flow (gpm)	Design Flow (gpm)	Pipeline Size (inches)
Alternative 2	LE Extraction Segment 1	Ext Well	GWTP	900	400	600	8
	LE Extraction Segment 2	Ext Well	GWTP	500	800	1200	10
	LE Extraction Segment 3	Ext Well	GWTP	2600	1150	1800	14
	Treated Potable Water to SFS Storage Tk	GWTP	SFS Tank	9200	900	1350	12
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	9200	300	450	8
	<i>Total</i>			22400			
Alternative 3	LE Extraction Segment 1	Ext Well	GWTP	900	230	350	6
	LE Extraction Segment 2	Ext Well	GWTP	500	470	700	8
	LE Extraction Segment 3	Ext Well	GWTP	14700	700	1050	12
	CE Extracted Water Pipeline	Ext Well	GWTP	4500	350	500	8
	NE Extracted Water Pipeline	Ext Well	GWTP	6100	350	500	8
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	6000	163	250	6
	Reclaim Water to Trunk Line Tie-In @ Florence	GWTP	Florence Ave	6000	1138	1750	14
	<i>Total</i>			38700			
Alternative 4	LE Extraction Segment 1	Ext Well	GWTP	900	230	350	6
	LE Extraction Segment 2	Ext Well	GWTP	500	470	700	8
	LE Extraction Segment 3	Ext Well	GWTP	14700	700	1050	12
	CE Extracted Water Pipeline	Ext Well	GWTP	4500	350	500	8
	NE Extracted Water Pipeline	Ext Well	GWTP	6100	350	500	8
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	6000	325	500	8
	Treated Water to Injection Wells	GWTP	Injection wells	500	975	1500	14
	<i>Total</i>			33200			
Alternative 5	LE Extraction Segment 1	Ext Well	GWTP	900	230	375	6
	LE Extraction Segment 2	Ext Well	GWTP	500	470	750	8
	LE Extraction Segment 3	Ext Well	GWTP	14700	700	1125	12
	CE Extracted Water Pipeline	Ext Well	GWTP	4500	330	540	8
	NE Extracted Water Pipeline	Ext Well	GWTP	6100	330	540	8
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	6000	163	275	6
	Treated Water to San Gabriel River	GWTP	S. G River	9200	1138	1925	14
	<i>Total</i>			41900			
Alternative 6	LE Extraction Segment 1	Ext Well	GWTP	900	230	350	6
	LE Extraction Segment 2	Ext Well	GWTP	500	470	700	8
	LE Extraction Segment 3	Ext Well	GWTP	14700	700	1050	12
	CE Extracted Water Pipeline	Ext Well	GWTP	4500	350	500	8
	NE Extracted Water Pipeline	Ext Well	GWTP	6100	350	500	8
	Brine Line to Indust Sewer Tie-In(@Florence)	GWTP	Florence Ave	6000	325	500	8
	Treated Potable Water to SFS Storage Tk	GWTP	SFS Tank	8000	975	1500	14
	<i>Total</i>			40700			



TABLE B-15

Capital Cost – New Extraction Well

Feasibility Study, Omega Chemical Superfund Site OU2

Item	Description	Estimated Depth/Quantity	Number of Locations	Estimated Total Quantity	Unit	Unit Cost	Total Cost	Cost Estimate Source
<b>Installation of a New Extraction Well</b>								
	Mobilization/Demobilization/Cleanup (one-time charge)			1	Lump Sum	\$32,783.33	\$32,783	Layne - Palmdale 2005 divided by three
	Sound Control	1	1	1	Each	\$20,000.00	\$20,000	
	Conductor Casing and Sanitary Seal - drill 30-inch (minimum) hole and furnish and install 24-inch conductor casing	50	1	50	Linear foot	\$500.00	\$25,000	GSWC - Ojai, 2004
	Drilling Reverse Mud Rotary/Ream (24-inch)	220	1	220	Linear foot	\$125.00	\$27,500	GSWC - Ojai, 2004
	Geophysical	1	1	1	Each	\$5,100.00	\$5,100	GSWC - Ojai, 2004
	Steel Well Casing - 18-inch including 10' sump	130	1	130	Linear foot	\$150.00	\$19,500	PVOU - 2004
	Stainless Steel Screen - 18-inch	80	1	80	Linear foot	\$250.00	\$20,000	PVOU - 2004
	Dissimilar Metals Connector	1	1	1	Each	\$2,800.00	\$2,800	PVOU - 2004
	Gravel Tube	180	2	360	Linear foot	\$23.00	\$8,280	GSWC - Ojai, 2004
	Sound Tube	150	2	300	Linear foot	\$17.00	\$5,100	GSWC - Ojai, 2004
	Filter Pack	120	1	120	Linear foot	\$17.00	\$2,040	PVOU - 2004
	Annular Grout or Neat Cement	100	1	100	Linear foot	\$28.00	\$2,800	PVOU - 2004
	Well Development - Primary & Secondary	24	1	24	Hours	\$230.00	\$5,520	Layne - Palmdale 2005
	Development Rig			1	Lump Sum	\$3,825.00	\$3,825	Layne - Palmdale 2005
	Mobilization/Demobilization/Cleanup							
	Step-Rate Aquifer Test	24	1	24	Hours	\$230.00	\$5,520	Layne - Palmdale 2005
	Constant-Rate Aquifer Test	72	1	72	Hours	\$230.00	\$16,560	Layne - Palmdale 2005
	Video Camera Survey	1	1	1	Each	\$1,100.00	\$1,100	Layne - Palmdale 2005
	Disinfect Well	1	1	1	Each	\$1,650.00	\$1,650	GSWC - Ojai, 2004
								\$241,418
<b>Pump and Power Service Connection</b>								
	Well Head, including piping, valves, meters, etc	1	1	1	Each	\$20,000.00	\$20,000	Used WNOU Eng. Est. as guide
	Submersible Pump/Motor include install.	1	1	1	Each	\$65,000.00	\$65,000	"
	Power service connection and panel	1	1	1	Each	\$28,000.00	\$28,000	
								\$133,024
Scope Item	Description	Estimated Quantity	Units	Unit Costs	Single Well Costs	No. of Wells	Total Costs	Cost Estimate Source
<b>Task - Extraction Well</b>								
	Mobilization/demobilization of roll off bins (10 CY bins)	3	EA	\$600.00	\$1,800.00	1	\$1,800	WDC, Santa Clarita project 2006
	Rental of roll off bins (75 day average)	225	DAY	\$18.00	\$4,050.00	1	\$4,050	WDC, Santa Clarita project 2006
	Mobilization/demobilization of tanks for liquid waste	3	EA	\$1,000.00	\$3,000.00	1	\$3,000	WDC, Santa Clarita project 2006
	Rental of tanks for liquids (75 day average)	225	DAY	\$35.00	\$7,875.00	1	\$7,875	WDC, Santa Clarita project 2006
	Offsite disposal of soil cuttings as non-hazardous waste	38	TON	\$58.00	\$2,227.04	1	\$2,227	WDC, Santa Clarita project 2006
	Disposal of drilling mud and high solids water as non-hazardous waste	20,000	GAL	\$0.30	\$6,000.00	1	\$6,000	WDC, Santa Clarita project 2006
	Construct Basin for Settling/ Infiltration of Well Development Water	1	EA	\$5,000.00	\$5,000.00	1	\$5,000	WDC, Santa Clarita project 2006
								\$
								35,260

**TABLE B-15**

Capital Cost – New Extraction Well

Feasibility Study, Omega Chemical Superfund Site OU2

Item	Description	Estimated Depth/Quantity	Number of Locations	Estimated Total Quantity	Unit	Unit Cost	Total Cost	Cost Estimate Source
	<b>Subtotal "A"</b>						\$ 409,701	
NOTES:								
1. All equipment cost adjustments for size based on the formula: Adjusted Cost = Orig. Cost * (Adjusted Size/Orig. Size) EXP X								
where "X" is 0.33 for pumps, 0.57 for Tanks, 0.62 for towers, and 0.6 for other process equipment.								
2. Cost escalation adjustments from the following time periods were used, if needed, as appropriate.								
<b>Escalation Factors</b>								
2000-2009: 36.02%								
2003-2009: 31.61%								
2004-2009: 25.74%								
2005-2009: 17.72								
2008-2009: 4.21%								

**TABLE B-16**

Capital Cost – New Injection Well  
Feasibility Study, Omega Chemical Superfund Site OU2

Item	Description	Estimated Depth/Quantity	Number of Locations	Estimated Total Quantity	Unit	Unit Cost	Total Cost	Cost Estimate Source
<b>Installation of a New Injection Well</b>								
	Mobilization/Demobilization/Cleanup (one-time charge)			1	Lump Sum	\$32,783.33	\$32,783	Layne - Palmdale 2005 divided by two
	Sound Control	1	1	1	Each	\$20,000.00	\$20,000	
	Conductor Casing and Sanitary Seal - drill 30-inch (minimum) hole and furnish and install 24-inch conductor casing	50	1	50	Linear foot	\$500.00	\$25,000	GSWC - Ojai, 2004
	Drilling Reverse Mud Rotary/Ream (24-inch)	525	1	525	Linear foot	\$125.00	\$65,625	GSWC - Ojai, 2004
	Geophysical	1	1	1	Each	\$5,100.00	\$5,100	GSWC - Ojai, 2004
	Steel Well Casing - 18-inch	425	1	425	Linear foot	\$150.00	\$63,750	PVOU - 2004
	Stainless Steel Screen - 18-inch	100	1	100	Linear foot	\$250.00	\$25,000	PVOU - 2004
	Dissimilar Metals Connector	1	1	1	Each	\$2,800.00	\$2,800	PVOU - 2004
	Gravel Tube	200	2	400	Linear foot	\$23.00	\$9,200	GSWC - Ojai, 2004
	Sound Tube	300	2	600	Linear foot	\$17.00	\$10,200	GSWC - Ojai, 2004
	Filter Pack	125	1	125	Linear foot	\$17.00	\$2,125	PVOU - 2004
	Annular Grout or Neat Cement	400	1	400	Linear foot	\$28.00	\$11,200	PVOU - 2004
	Well Development - Primary & Secondary	24	1	24	Hours	\$230.00	\$5,520	Layne - Palmdale 2005
	Development Rig			1	Lump Sum	\$3,825.00	\$3,825	Layne - Palmdale 2005
	Mobilization/Demobilization/Cleanup							
	Step-Rate Aquifer Test	24	1	24	Hours	\$230.00	\$5,520	Layne - Palmdale 2005
	Constant-Rate Aquifer Test	72	1	72	Hours	\$230.00	\$16,560	Layne - Palmdale 2005
	Video Camera Survey	1	1	1	Each	\$1,100.00	\$1,100	Layne - Palmdale 2005
	Disinfect Well	1	1	1	Each	\$1,650.00	\$1,650	GSWC - Ojai, 2004
								\$361,351.35
<b>Wellhead and Drop Pipe</b>								
	Well Head, including piping, valves, meters, etc	1	1	1	Each	\$20,000.00	\$20,000	Used WNOU Eng. Est. as guide
	Pump Riser Pipe (stainless steel)	500	1	500	LF	\$35.00	\$17,500	PVOU - 2004
	Power service connection and panel	1	1	1	Each	\$15,000.00	\$15,000	
								\$61,803.00
Scope Item	Description	Estimated Quantity	Units	Unit Costs	Single Well Costs	No. of Wells	Total Costs	Cost Estimate Source
<b>Task - Injection Well</b>								
	Mobilization/demobilization of roll off bins (10 CY bins)	6	EA	\$600.00	\$3,600.00	1	\$3,600	WDC, Santa Clarita project 2006
	Rental of roll off bins (75 day average)	450	DAY	\$18.00	\$8,100.00	1	\$8,100	WDC, Santa Clarita project 2006
	Mobilization/demobilization of tanks for liquid waste	3	EA	\$1,000.00	\$3,000.00	1	\$3,000	WDC, Santa Clarita project 2006
	Rental of tanks for liquids (75 day average)	225	DAY	\$35.00	\$7,875.00	1	\$7,875	WDC, Santa Clarita project 2006
	Offsite disposal of soil cuttings as non-hazardous waste	92	TON	\$58.00	\$5,314.53	1	\$5,315	WDC, Santa Clarita project 2006
	Disposal of drilling mud and high solids water as non-hazardous waste	40,000	GAL	\$0.30	\$12,000.00	1	\$12,000	WDC, Santa Clarita project 2006
	Construct Basin for Settling/ Infiltration of Well Development Water	1	EA	\$5,000.00	\$5,000.00	1	\$5,000	WDC, Santa Clarita project 2006
							\$	52,844

**TABLE B-16**

Capital Cost – New Injection Well  
Feasibility Study, Omega Chemical Superfund Site OU2

Item	Description	Estimated Depth/Quantity	Number of Locations	Estimated Total Quantity	Unit	Unit Cost	Total Cost	Cost Estimate Source
	<b>Subtotal "A"</b>						\$ 404,348	
NOTES:								
1. All equipment cost adjustments for size based on the formula: Adjusted Cost = Orig. Cost * (Adjusted Size/Orig. Size) EXP X								
where "X" is 0.33 for pumps, 0.57 for Tanks, 0.62 for towers, and 0.6 for other process equipment.								
2. Cost escalation adjustments from the following time periods were used, if needed, as appropriate.								
<b>Escalation Factors</b>								
2000-2009: 36.02%								
2003-2009: 31.61%								
2004-2009: 25.74%								
2005-2009: 17.72								
2008-2009: 4.21%								

## **Appendix C**

# **Environmental Footprint Assessment for Omega FS**

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# Environmental Footprint Assessment for Omega FS

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## Introduction

In April 2008, the Office of Solid Waste and Emergency Response (OSWER) issued a technology primer to help consider all environmental effects of remedy implementation for contaminated sites and incorporate options to maximize the net environmental benefit of cleanup actions. In August 2009, OSWER issued a new policy to evaluate cleanup actions comprehensively to ensure protection of human health and the environment and to reduce the environmental footprint of cleanup activities, to the maximum extent possible, through considering *Principles for Green Remediation*. In considering these Principles, OSWER cleanup programs will assure that the cleanups and subsequent environmental footprint reduction occur in a manner that is consistent with the statutes and regulations governing EPA cleanup programs and without compromising cleanup objectives, community interests, the reasonableness of cleanup timeframes, or the protectiveness of the cleanup actions.

This new policy cites five elements of a green cleanup assessment:

- Total Energy Use and Renewable Energy Use
- Air Pollutants and Greenhouse Gas Emissions
- Water Use and Impacts to Water Resources
- Materials Management and Waste Reduction
- Land Management and Ecosystems Protection

With the exception of the No Action Alternative, each alternative evaluated in the FS was against the above five elements. The No Action Alternative has no remedial activities and its environmental footprint would be zero.

## Assessment Methodology

The green evaluation first quantifies the environmental footprint for each remedial alternative in the five categories listed above and explained below. The results are then scaled and summed, and an environmental score is assigned to each alternative, ranging from one (worst) to five (best). The methodology is described in detail below.

Each alternative was evaluated for its environmental footprint and an approximate inventory of environmental impacts was developed. The impacts were quantified based on the construction activities and 30 years of operations and maintenance used in the feasibility study (FS) cost estimate (Appendix B). Table C-1 provides a summary of key elements (such as pipeline length, energy use, etc.) that were considered in the assessment along with estimated quantities for each. These quantities provide the basis of the environmental footprint analysis.

As all four alternatives use similar technologies, this analysis is more focused on the relative differences between the four alternatives and does not focus specifically on estimating the actual environmental impacts of each alternative. This approach is preferable for an FS where the remedial alternatives are ranked relative to each other.

The elements of the analysis that were not considered in detail, because they are all comparable among the four alternatives, are identified as follows:

- Flow rates for each alternative are approximately comparable. Any differences in flow rates are represented by the other factors evaluated in this analysis.
- The number of extraction wells and monitoring wells are approximately comparable. The differences in the number of extraction or monitoring wells are insignificant for this evaluation.
- Groundwater and process monitoring of the system are similar for all four alternatives.
- Infrastructure and siting for the groundwater treatment plant sites are very similar for all four alternatives.

Each of the key elements evaluated was mapped to the five principles. Note that it is possible for a single inventory item to be mapped to more than one element, as described in Table C-2. For example, the length of the extraction and discharge piping can show up in impacts to:

- Total Energy Use and Renewable Energy – through amount of diesel fuel required to install the piping (e.g., through trenching and backfilling operations)
- Air Pollutants and Greenhouse Gas Emissions – through the manufacturing and installation of extraction and discharge piping
- Materials Management and Waste Reduction – through the volume of excavated soil that must be removed, backfill that must be installed, and raw and processes materials required to complete the extraction and discharge lines
- Land Management and Ecosystems Protection – through the amount of land impacted by installing the extraction and discharge lines

Similarly, the generation of waste brine has an impact on the environmental score for water use and resources, but also on the score for waste generation.

Information in Table C-1 was further consolidated in Table C-3 to make the comparison more direct, specifically:

- Total footage of extraction and discharge piping was summed.
- Total chemicals were summed up to be represented by a single number. (All the chemicals are inorganic and do not contain toxic metals.)

Specific environmental metrics (e.g., greenhouse gases, particulate matter, VOC emissions, etc.) of each impact item in Tables C-1 and C-3 were not estimated for this analysis. These environmental metrics are accounted for by considering that they are strongly correlated to the impact items presented in Tables C-1 and C-3.

For example, a typical environmental footprint analysis would identify environmental metrics for each inventory item of a project - such as individual chemicals - and estimate the environmental footprint of each chemical using a reference database (e.g., SimaPro, GaBi4). These databases provide numerous environmental metrics for an individual item. Rather than complete this level of a detailed evaluation, this analysis recognizes that the more chemicals used for the project, the greater the environmental impact will be. As shown in Table C-3 (an abbreviated version of Table C-1), Alternatives 3 and 5 use significantly more chemicals than Alternatives 2, 4, and 6; consequently, the environmental impacts associated with chemical usage would be much greater with the former two alternatives, both in terms of air emissions and material management elements.

As represented in Table C-3, increasing values represent greater negative environmental impacts. The least impact a factor could have would be zero. The values shown in Table C-3 were normalized to a scoring range of 1 to 3 (one representing the greatest environmental impact and three representing the least environmental impact) in Table C-4. The normalized range was anchored to the highest score among the five alternatives. Corresponding to scores 1, 2, and 3, the alternatives can be ranked as Low, Medium, and High.

As an example of the above normalization, consider the metric "Extraction and Discharge Pipe Lengths." The "best" score would be one where an alternative did not include any extraction or discharge piping; this alternative would receive a 5. The lowest scoring alternative would be Alternative 5 with 41,900 feet of piping; this alternative would receive a score of 1. The scores for Alternatives 2, 3, 4, and 6 are computed by scaling their respective pipeline lengths in the range of 0 and 41,900 feet to the 1 to 3 range.

Each metric within one of the five elements was scored using the above methodology and then the category score was calculated as a simple average score of the individual metric scores under that category. The overall score for each alternative was calculated as a simple average of the category scores. Simple averages were used to maintain equal importance of each category. Should a certain category be given more importance (e.g., water use and water resources), a weighted average would be appropriate. However, because the weighting would be subjective without specific guidelines, policy directives, or regulatory framework, a simple average was used in this assessment.

The five categories used for this evaluation are briefly described below.

## **Total Energy Use and Renewable Energy**

The total energy use includes energy consumption for the construction of the remedy, and for operations and maintenance for the planned remedy duration. The renewable energy use covers the portion of total energy use that is from renewable sources including sources developed as part of the remedy.

As shown in Table C-4, extraction and discharge pipe lengths, LGAC usage, and power consumption have impacts on total energy use and renewable energy. The specific implications of each item on total energy use and renewable energy are listed in Table C-2. These three individual impacts were scored and then the overall score for this principle was calculated as an average of the three scores.

## **Air Pollution and GHG Emissions**

The emissions include air pollutants such as toxic gases and dust, and greenhouse gases (GHGs) emitted during the remedy construction and operation.

As shown in Table C-4, extraction and discharge pipe lengths, LGAC usage, ion-exchange resin, chemical usage, and power consumption have impacts on air pollution and GHG emissions. The specific implications of each item on air pollution and GHG emissions are listed in Table C-2. These five individual metrics were scored and then the overall score for this principle was calculated as an average of the five scores.

## **Water Use and Impacts to Water Resources**

This category includes the impacts of the remedy on water resources and water use. For pump-and-treat systems, the main criteria are the assessment of the integration of the remedial extraction into the framework of existing groundwater management within the basin and the evaluation of the end use of the treated water.

As shown in Tables C-2 and C-4, the only impact to water use and water resources is the disposal of waste brine. For the purposes of this evaluation, any water that can be used for fresh water purposes (e.g., reinjection back into the aquifer, treated for potable water supply) was considered equally beneficial. The end use of the treated water under each of the four alternatives is considered freshwater use for this assessment. Brine that is created as a waste product under each of the four alternatives represents water that cannot be used for freshwater purposes. No other impacts identified in Tables C-1 and C-2 were considered to impact water use and water resources. The overall score on this principle is the same as the score for the single metric.

## **Materials Management and Waste Reduction**

This category includes the environmental impacts resulting from the materials used and waste generated during the remedy construction and operation. For example, the materials include the chemicals used and the wastes include the by-products of groundwater treatment.

As shown in Table C-4, pipe lengths, LGAC usage, ion-exchange resin, chemical usage, waste by-products, and brine are mapped to materials management and waste reduction. The specific implications of each item on waste management and waste reduction are listed in Table C-2. These six individual metrics were scored and then the overall score for impacts on this principle was calculated as an average of the five scores.

## **Land Management and Ecosystems Protection**

This category addresses the protection of ecosystems and overall land use. As shown in Tables C-2 and C-4, the only impact to land management and ecosystems protection is the total land needed for the extraction and discharge lines. Ecosystems are not a factor in any of the four alternatives because there is no protected or sensitive habitat at OU2 (CH2M HILL, 2009). No other impacts identified in Tables C-1 and C-2 were considered for water use and water resources. The overall score on this principle is the same as the score for the single metric.

## Results of Assessment

Results for individual categories as well as total scores for each alternative are presented in Table C-4. An overview of each element is described below.

### Total Energy Use and Renewable Energy

Overall, the four alternatives scored relatively similarly on this element and none of the alternatives was considered very strong. From the perspective of “typical” remedial actions, these four alternatives draw considerable power. Onsite renewable power was not considered in this evaluation because of the considerable power requirements and the limited land space available. However, during the design process, the use of renewable energy to power components of the selected alternatives should be evaluated. The key factors were total power consumption and power required to manufacture and regenerate LGAC.

### Air Pollution and GHG Emissions

Alternative 2 scored best for this element, Alternatives 4 and 6 scored similarly, and Alternatives 3 and 5 also scored similarly and lowest. The key differentiators for this element were the air emissions associated with chemical manufacturing, single use ion-exchange resin, LGAC carbon regeneration, and diesel emissions associated with installation of extraction and discharge piping.

### Water Use and Impacts to Water Resources

Alternatives 3 and 5 scored the highest for this element because most of the extracted water was being used for a freshwater beneficial reuse and the lowest volume of waste brine was generated. It should be noted, however, that the beneficial use of the treated water under Alternative 3 would be offset by discharges to the ocean of reclaim water from other treatment facilities in the basin due to the limited demand for reclaim water. (To account for this offset, the score for water use and water resources in Table C-3 would be one.)

Alternatives 4 and 6 scored the lowest for this element because approximately 25 percent of the treated water will be wasted as brine reject stream that will have to be discharged to an industrial sewer. Alternative 2 scored slightly higher than Alternatives 4 and 6 because of similarly high fraction of waste brine.

### Materials Management and Waste Reduction

Alternative 2 scored highest for this element followed by Alternatives 4 and 6, and the lowest scoring Alternatives 3 and 5. Key differentiators within this element were the use of ion-exchange resin, amount of chemicals required, and waste brine produced.

### Land Management and Ecosystems Protection

Alternative 2 scored the best for this element followed by Alternatives 4, 3, 6, and 5 respectively. This metric was directly correlated to the amount of extraction and discharge piping that is installed so the alternative with the shortest total pipeline scored the highest.

## Overall Assessment

The total environmental scores are listed in Table C-4 and Figure C-1 presents a summary of each alternative and how each element scored within the total average score. Based on the above assessment, which focused on relative differences between the alternatives, Alternative 2 has the smallest environmental footprint, followed by Alternative 4, and Alternatives 3, 5, and 6, with total scores of 1.8, 1.4, 1.3, 1.3 and 1.3, respectively. Accordingly, Alternative 2 is ranked Medium and Alternatives 3, 4, 5, and 6 are ranked Low. It is noted that should the water use offset under Alternative 3 be counted; the overall score for this alternative would be the lowest at 1.1.

## References

U.S. Environmental Protection Agency (EPA). 2008. *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*. Office of Solid Waste and Emergency Response, EPA 542-R-08-002, April.

U.S. Environmental Protection Agency (EPA). 2009. *Draft Framework for Green Cleanup Standards at Contaminated Sites*. Office of Solid Waste and Emergency Response, EPA 542-R-08-002, April.

**Figure C-1**  
**Environmental Scores for Action Alternatives**

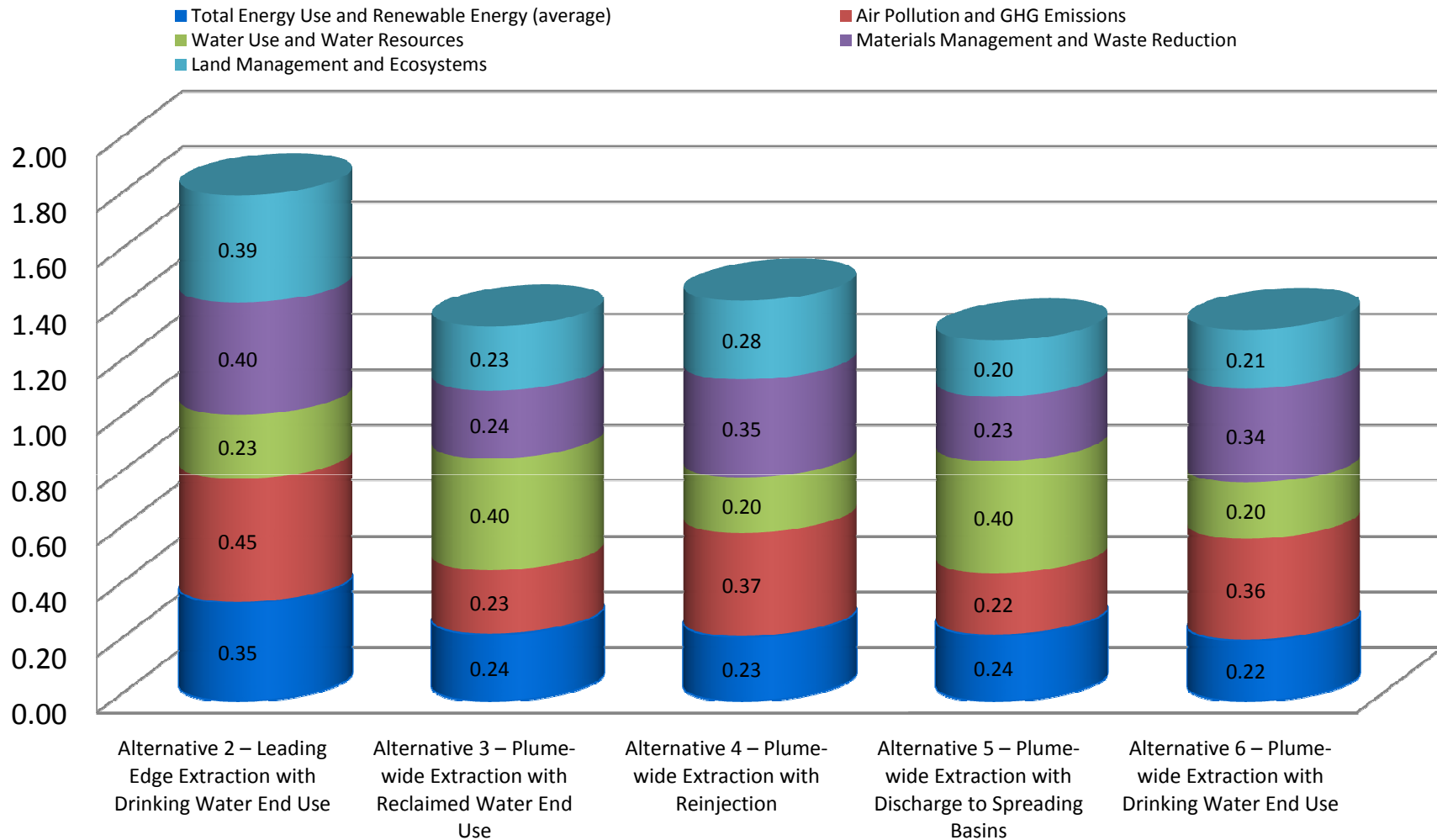




TABLE C-1  
 Summary of Environmental Impacts  
 Omega Chemical Corporation Superfund Site Feasibility Study

Alternative	Analysis Inputs												
	Extraction Rates (gpm)	Extraction & Discharge Pipe Lengths (feet)	LGAC Usage (pounds)	Single Use Resin Usage for Ion-Exchange Operation (cubic feet)	Hydrogen Peroxide Usage for Advanced Oxidation Process Operation (pounds)	Sodium Metabisulfate Usage (pounds)	NF or RO Operations [CIP, Consumables, etc.] (gallons)	H <sub>2</sub> SO <sub>4</sub> Adjustment (pounds)	NaOH Adjustment (pounds-dry)	Sodium Hypochlorite (pounds)	Waste Disposal [LGAC, Resin, Sludge (1% of LGAC use)] (tons)	Power Consumption (kilowatt-hour)	Waste Brine (gpm)
Alternative 1 – No Action	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Alternative 2 – Leading Edge Extraction with Drinking Water End Use	1,800	22,400	259,515	0	131,347	31,523	630,719,230	0	0	10,520	131	2,359,335	300
Alternative 3 – Plume-wide Extraction with Reclaimed Water End Use	2,000	38,700	343,100	950	142,293	34,150	683,280,769	1,034,361	1,034,361	0	192	3,262,546	160
Alternative 4 – Plume-wide Extraction with Reinjection	2,000	33,200	335,800	0	142,293	34,150	630,719,230	0	0	0	169	4,176,025	325
Alternative 5 – Plume-wide Extraction with Discharge to Spreading Basins	2,000	41,900	343,100	950	142,293	34,150	683,280,769	1,223,720	996,051	17,096	192	3,045,024	160
Alternative 6 – Plume-wide Extraction with Drinking Water End Use	2,000	40,700	335,800	0	142,293	34,150	683,280,769	0	0	0	169	3,819,931	325

Notes:  
 Input quantities were taken from Appendix B and Section 3 tables.  
 gpm = gallon per minute



TABLE C-2

Summary of Impact Factors And How They Contribute to Five Elements of Green Cleanups

Omega Chemical Corporation Superfund Site Feasibility Study

Impact Component	Total Energy Use and Renewable Energy	Air Pollution and Greenhouse Gas Emissions	Water Use and Water Resources*	Materials Management and Waste Reduction	Land Management and Ecosystems Protection
Extraction & Discharge Pipe Lengths (feet)	Diesel fuel used to trench and backfill	Diesel emissions and particulate matter as a result of construction		Piping and backfill for trenches; soil removal and disposal from trenches	Total land impacted by installation of extraction and discharge lines
LGAC Usage (pounds)	Power used to activate and regenerate LGAC	Emissions associated with power required to activate and regenerate LGAC		Amount of carbon used; waste reduction in form of re-use of carbon through regeneration	
Single Use Resin Usage for Ion-Exchange Operation (cubic feet)		Emissions associated with manufacturing of impact component		Material required to manufacture impact component	
Hydrogen Peroxide Usage for Advanced Oxidation Process Operation (pounds)		Emissions associated with manufacturing of impact component		Material required to manufacture impact component	
Sodium Metabisulfate Usage (pounds)		Emissions associated with manufacturing of impact component		Material required to manufacture impact component	
NF or RO Operations [CIP, Consumables, etc.] (gallons)				Disposal of waste ion-exchange resin	
H <sub>2</sub> SO <sub>4</sub> Adjustment (pounds)		Emissions associated with manufacturing of impact component		Material required to manufacture impact component	
NaOH Adjustment (pounds-dry)		Emissions associated with manufacturing of impact component		Material required to manufacture impact component	
Sodium Hypochlorite (pounds)		Emissions associated with manufacturing of impact component		Material required to manufacture impact component	
Waste Disposal [LGAC, Resin, Sludge (1% of LGAC use)] (tons)				Disposal of process wastes	
Power Consumption (kilowatt-hour)	Power required to operate groundwater treatment systems	Air emissions associated with power production			
Waste Brine			All brine water represents a negative impact on using water for fresh water purposes	Disposal of waste brine from RO Process	

\* Based on beneficial reuse of water.



TABLE C-3  
Consolidation of Similar Impacts  
Omega Chemical Corporation Superfund Site Feasibility Study

Impact Component	Alternative 2 – Leading Edge Extraction with Drinking Water End Use	Alternative 3 – Plume-wide Extraction with Reclaimed Water End Use	Alternative 4 – Plume-wide Extraction with Reinjection	Alternative 5 – Plume-wide Extraction with Discharge to Spreading Basins	Alternative 6 – Plume-wide Extraction with Drinking Water End Use	Low Anchor	Low Range	High Range
Extraction & Discharge Pipe Lengths (feet)	22,400	38,700	33,200	41,900	40,700	0	22,400	41,900
LGAC Usage (pounds)	259,515	343,100	335,800	343,100	335,800	0	259,515	343,100
Single Use Resin Usage for Ion- Exchange Operation (pounds)	0	950	0	950	0	0	0	950
Total Chemical usage (pounds)	173,390	2,245,165	176,443	2,413,310	176,443	0	173,390	2,413,310
Waste Disposal [LGAC, Resin, Sludge (1% of LGAC use)] (tons)	131	192	169	192	169	0	131	192
Power Consumption (kilowatt-hour)	2,359,335	3,262,546	4,176,025	3,045,024	3,819,931	0	2,359,335	4,176,025
Waste Brine	300	160	325	160	325	0	160	325



TABLE C-4

Normalized Scores for Metrics and Scoring for Each Alternative

Alternative 4 – Plume-wide Extraction with Reinjection

Omega Chemical Corporation Superfund Site Feasibility Study

	Alternative 2 – Leading Edge Extraction with Drinking Water End Use	Alternative 3 – Plume-wide Extraction with Reclaimed Water End Use	Alternative 4 – Plume-wide Extraction with Reinjection	Alternative 5 – Plume-wide Extraction with Discharge to Spreading Basins	Alternative 6 – Plume-wide Extraction with Drinking Water End Use
Total Energy Use and Renewable Energy (average)	1.8	1.2	1.2	1.2	1.1
Extraction & Discharge Pipe Lengths (feet)	1.9	1.2	1.4	1.0	1.1
LGAC Usage (pounds)	1.5	1.0	1.0	1.0	1.0
Power Consumption (kilowatt-hour)	1.9	1.4	1.0	1.5	1.2
Air Pollution and GHG Emissions (average)	2.2	1.1	1.9	1.1	1.8
Extraction & Discharge Pipe Lengths (feet)	1.9	1.2	1.4	1.0	1.1
LGAC Usage (pounds)	1.5	1.0	1.0	1.0	1.0
Single Use Resin Usage for Ion-Exchange Operation (pounds)	3.0	1.0	3.0	1.0	3.0
Total Chemical usage (pounds)	2.9	1.1	2.9	1.0	2.9
Power Consumption (kilowatt-hour)	1.9	1.4	1.0	1.5	1.2
Water Use and Water Resources	1.2	2.0	1.0	2.0	1.0
Materials Management and Waste Reduction (average)	2.0	1.2	1.8	1.2	1.7
Extraction & Discharge Pipe Lengths (feet)	1.9	1.2	1.4	1.0	1.1
LGAC Usage (pounds)	1.5	1.0	1.0	1.0	1.0
Single Use Resin Usage for Ion-Exchange Operation (pounds)	3.0	1.0	3.0	1.0	3.0
Total Chemical usage (pounds)	2.9	1.1	2.9	1.0	2.9
Waste Disposal [LGAC, Resin, Sludge (1% of LGAC use)] (tons)	1.6	1.0	1.2	1.0	1.2
Waste Brine	1.2	2.0	1.0	2.0	1.0
Land Management and Ecosystems Protection	1.9	1.2	1.4	1.0	1.1
Total Score	1.8	1.3	1.4	1.3	1.3
Rating	MEDIUM	LOW	LOW	LOW	LOW

Explanation

\* Total score is the average of the scores shown on the yellow lines.

Score values range from 1 to 3.

